United States Court of Appeals
for the
District of Columbia Circuit

TRANSCRIPT OF RECORD

BRIEF AND APPENDIX
FOR APPELLANT

UNITED STATES
COURT OF APPEALS FOR THE
DISTRICT OF COLUMBIA

FILED AUG 27 1943

Joseph W. Stewart
CLERK

IN THE

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA

No. 8517

576

SAMUEL S. KISTLER, *Appellant*,

v.

CONWAY P. COE, Commissioner of Patents, *Appellee*.

BRIEF FOR APPELLANT.

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Of Counsel.

PRESS OF BYRON S. ADAMS, WASHINGTON, D. C.

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IN THE

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA

No. 8517

SAMUEL S. KISTLER, *Appellant,*

v.

CONWAY P. COE, Commissioner of Patents, *Appellee.*

BRIEF FOR APPELLANT.

JURISDICTIONAL STATEMENT.

This is an appeal from a decision of the District Court of the United States for the District of Columbia dismissing a complaint brought by Samuel S. Kistler against Conway P. Coe in his official capacity as Commissioner of Patents of the United States Patent Office for the issuance of a patent on an application of said Kistler.

The District Court had jurisdiction under the provisions of the Revised Statutes, Section 4915; U. S. C., Title 35, Sec. 63 (Complaint, paragraph 1, App. p. 2).

This Court has jurisdiction of this appeal under the provisions of U. S. C., Title 28, Sec. 225a.

STATEMENT OF THE CASE.

The complaint requests that the Commissioner of Patents be directed to issue a patent to plaintiff upon an application for Letters Patent Serial No. 135,801 for improvements in Thermally Insulated Structures and Methods of Making the Same, filed in the United States Patent Office on April 8, 1937, containing claims numbered 1 to 9, 13 and 14 in said application.

The invention relates to a method of thermally insulating structures by providing an enclosed space substantially surrounding the structure and filling the space with an inorganic aerogel, such as silica aerogel, and to the thermally insulated structures thereby produced.

Claim 1 is directed to a thermally insulated structure comprising, at least, two spaced walls having an inorganic aerogel disposed in the space therebetween as a thermal insulator.

Claim 2 is directed particularly to such a structure having **heated** material in the interior thereof, while claim 3 is directed to such a structure having **cooled** material in the interior thereof.

Claim 4 defines the inorganic aerogel as "being in sufficiently fine state of subdivision to give it flowing properties whereby it may be poured into the space between the walls''.

Claim 5 is directed specifically to an insulated structure having **silica** aerogel between the walls.

Claim 6 is directed to a method of thermally insulating structures including providing an enclosed space surrounding the structure and filling the space with silica aerogel in a sufficiently fine state of subdivision to flow into said space.

Claim 7 is similar to claim 6 with the added step of sealing the space.

Claim 8 is similar to claim 7 with the further step of evacuating the space before sealing it.

Claim 9 is directed to a thermally insulating structure, particularly adapted for use as a refrigerator and including silica aerogel between the inner and outer walls.

Claim 13 defines a thermally insulating structure having free-flowing silica aerogel between spaced walls thereof and including means for preventing leakage of the aerogel from between the walls.

Claim 14 is similar to claim 13 with the further limitation that the silica aerogel forms a support for the spaced walls.

All of the claims were finally rejected by the Examiner as unpatentable over the following patents:

Stanley U. S. Patent 1,071,817, September 2, 1913
Schellens U. S. Patent 2,038,763, April 28, 1936
Kistler, U. S. Patent 2,093,454, September 21, 1937

The Kistler patent 2,093,454 issued to appellant on an application pending in the Patent Office when the application involved in this appeal was filed.

The following grounds of rejection were alleged in the Examiner's Statement (App. pp. 87-91):

1. That the claims are drawn to an old combination.

2. That the claims are unpatentable over either Schellens or Stanley in view of Kistler.

3. That the claims are unpatentable over the claims of Kistler, specifically claims 10, 18 and 19.

In the decision of the Board of Appeals of June 17, 1941 (App. pp. 92-93),' the Examiner's rejection of the claims was affirmed.

In appellee's answer to the complaint, appellee relied on the grounds of rejection given by the Examiner in his statement and by the Board of Appeals in its decision.

Appellant's testimony before the District Court was directed to showing the unpredictable advantages of the invention defined in the claims and particularly to showing that the invention provided new insulated structures having properties previously thought to be unattainable by experts in the art.

No testimony was taken on behalf of appellee.

The District Court dismissed appellant's complaint, holding that the claims define no invention over appellant's patent No. 2,093,454, and particularly, that it was not further invention for appellant to use the material of his patent as an insulating material for thermally insulated structures.

Appellant contends that the decision of the District Court is erroneous as a matter of law because the uncontradicted evidence presented by appellant clearly shows that the invention defined by the claims involves advantages unpredictable by those skilled in the art, and because the claims are directed to an invention distinct from the invention claimed in appellant's patent No. 2,093,454.

STATEMENT OF POINTS RELIED ON.

1. Appellant contends that the District Court erred in not finding that the uncontradicted testimony and evidence presented by appellant clearly shows that the advantages of the claimed invention were unpredictable, if not inconceivable, by experts in the art of thermal insulation when the invention was made.

2. Appellant contends that the District Court erred in not finding that the claimed invention is patentably distinct from the invention claimed in appellant's patent No. 2,093,454.

3. Appellant contends that the District Court erred in holding that the claims define no invention over appellant's patent No. 2,093,454.

SUMMARY OF ARGUMENT.

The claims in appellant's application are patentable over the prior art because they define a novel insulating structure and method utilizing a previously unknown class of substances, whose nearest known analogues have not been used or suggested for use in insulating structures, and because the insulated structures of the invention embody properties previously thought to be unattainable by insulation experts.

The claims are patentable over appellant's patent because they are directed to a different invention from that claimed in the patent. The invention claimed in appellant's application is independent of the invention claimed in this patent and lies in a different field or art from the patented invention.

THE HISTORY OF THE INVENTION.

"Aerogel" is a name applied by appellant Kistler to a new class of substances or new form of matter discovered by him and obtained by removing liquid from inorganic gels at temperatures approaching the critical temperature of the liquid. The term "gel" is applied to colloidal substances in the solid state whether they contain liquid or not. Normally, they are obtained by precipitation from liquid dispersions or solutions and primarily contain relatively large amounts of liquid held in a framework of the colloidal substance. It has long been known that the removal of the liquid from such a gel structure by evaporation is accompanied by a very substantial decrease in volume of the gel. Normally the gel shrinks on drying to a small fraction of its original volume.

Some time prior to 1930 Kistler conceived that useful products might be obtained if the liquid content of gelatinous substances could be removed therefrom without the concomitant shrinkage which had always been encountered in the past. He had the further conception that this goal might be achieved if the gelatinous substance could be heated to a temperature at or above the "critical temperature" of the liquid before any substantial volatilization of the liquid occurs. The critical temperature of a substance is the temperature at or above which the substance may no longer exist as a liquid regardless of the pressure applied to the substance. At this temperature the liquid in the gel has little or no surface tension. It has, in effect, been converted into vapor within the pores of the gel substance and may be removed at this temperature without collapse of the gel structure.

Kistler accomplished this purpose, which he had conceived, by heating the gel in a closed container in the presence of sufficient liquid to build up rapidly a high pressure, and by releasing vapor of the liquid from the container only after the temperature in the container had reached the critical temperature of the liquid. In actual practice it has been found advantageous to replace the water content of "aquagels" with a liquid, such as alcohol, having a substantially lower critical temperature than water, thereby making it possible to operate at much lower temperatures and pressures.

The products obtained in this way were found to have a number of novel properties, and, as a group, were designated by Kistler as "aerogels". The aerogels are extremely light and microporous and constitute a new form of matter. A typical silica aerogel obtained from gelatinous silica by Kistler's method contains in a given volume only about 5 per cent of solids, that is, only about 5 per cent of the volume occupied by the material consists of solid matter.

The new aerogels were found to be useful for a number of purposes, for example, in imparting a flat finish to lacquer films, as an anti-tack agent for raincoats and the like, for preserving the free-flowing properties of powdered materials and for adjusting the viscosity and penetration of printing inks (App. pp. 14-15). They also were found to be useful as catalyst supports, as ultrafilters for gas masks and as polishing abrasives (Kistler patent 2,093,454, page 3, App. p. 80).

The invention involved in the present appeal arose out of Kistler's subsequent scientific investigations of the size of the pores in the aerogel structure. He found that these pores had dimensions too small for measurement by conventional methods. Optical tests had indicated that the pore structure was very fine compared to the wave length of light.

It then occurred to Kistler that the pore diameters might be less than the mean free path of air molecules and that the new material might therefore have a heat conductivity less than that of the "ideal" insulator, still air. This thought was the basis both of a new scientific procedure and of a conception of a new type of heat-insulated structures having thermal insulation capacities previously thought impossible.

The new scientific procedure is described in Kistler's article entitled "The Relation Between Heat Conductivity and Structure in Silica Aerogel" published in the Journal of Physical Chemistry for January 1935 (Appellant's Exhibit 11, App. pp. 47-49). The new heat-insulated structure is described and claimed in the application involved in this appeal.

Kistler's new aerogel substances and his method of making them were fully described in an application for patent which eventually issued as U. S. patent No. 2,093,454. In this patent he disclosed in considerable detail methods of making the new products and the characteristic features and properties of the products including their low apparent specific gravities, their very high catalytic activities and their low heat conductivity. He also described briefly his conception of utilizing the new aerogels in the production of heat insulating structures and referred to the application in this appeal, which was filed prior to the issuance of his patent, as "covering unclaimed subject matter disclosed in this application" (U. S. patent 2,093,454, page 5, right column, lines 1-4).

He did not claim in his patent, or receive any claims for, the insulating structure or method of making it described and claimed in the application on appeal. The claims of his patent are all directed either to his new aerogels or to the method of making them.

THE NATURE OF THE INVENTION.

Insulation is an old and well-developed art and the materials useful in heat insulation have been thoroughly examined and tested. The thermal insulating values of various materials are known on a quantitative basis (Appellant's Exhibits 3 and 4, App. pp. 37-38).

Normally, the heat-insulating properties of materials are expressed in terms of the K factor which was defined by Professor Wilkes of Massachusetts Institute of Technology as "the B. T. U.'s that are transferred through a square foot in one hour for one inch of thickness and for each degree Fahrenheit difference in temperature'' (App. p. 17).

At the time the invention was made experts in the art of heat insulation were of the opinion that still air (dead air space) represented the ideal or lower limit of heat conductivity of materials containing air (App. p. 19).

In a publication of the United States Bureau of Standards, published October 17, 1929, entitled ''Thermal Insulation of Buildings'', the following statement is made on page 4 (Appellant's Exhibit 5, App. p. 39):

> '' * * * Since every known solid material has a greater thermal conductivity than air, it is evident that the conductivity of air fixes the lower limit of the conductivity of insulating materials containing air."

This statement is graphically illustrated by Fig. 2 on page 6 of the Bureau of Standards publication (Appellant's Exhibit 5, App. p. 40).

This lower limit of the thermal conductivity of insulating materials was not only accepted: it was, as the Bureau of Standards puts it, ''evident''. What could be more surprising, then, to an expert in the art than to be presented with a material having an insulating value **greater** than that of still air, or, stated another way, having a conductivity below that of still air.

As Professor Wilkes said in his testimony:

> "I believed, along with all other heat experts, that there was no material that would be better than—have a lower K value than—air. So when we made our first determination and found the value was lower than that of air, we went over our apparatus, actually rebuilt it in some respects, so as to eliminate any possibility of doubt, and we got the same results: it was still definitely better than air". (App. p. 20)

The relative insulating value of silica aerogel is graphically represented on a reproduction of the Bureau of Standards diagram in Appellant's Exhibit No. 6 (App. p. 41), wherein the new material is clearly shown to be definitely better than the "ideal insulation" of the chart.

The explanation of this surprising state of affairs is implicit in Kistler's original inventive conception, that a substance having pore dimensions less than the mean free path of molecules in air would have a lower heat conductivity than still air by increasing the number of impacts of the energy-carrying molecules (App. pp. 32-33).

The great practical advantage of Kistler's invention is illustrated by Appellant's Exhibit 7 (App. p. 42), described by the witness Wilkes (App. p. 23). This exhibit shows the increase in storage capacity of a standard commercial refrigerator obtained with appellant's invention. The 6½ cubic feet storage capacity or usable space of the commercial refrigerator is increased in appellant's invention to 9½ cubic feet without any increase in external dimensions.

The invention has not been applied to household refrigerators on a large scale. It has, like many other recent inventions, "gone to war". A part of this interesting story is told by the witness Wilkes (App. pp. 26-28). In brief, it was found that the new method of insulation of the invention made possible the economical maintaining of very low temperatures—as low as 120 degrees below zero—which are desirable in certain industrial operations, and this use has absorbed the present production capacity of the new material. (Appellant's Exhibits 8-10, App. pp. 43-45).

APPELLANT'S CONCEPTION WAS A TRUE ACT OF INVENTION.

The invention defined in the claims on appeal was not the mere substitution of one known material for another. The entire line of development, including the concept of a new type of substance, the concept of methods of making the new substance, and the concept of a new heat-insulating structure involving the new substance as one of its elements arose out of the mind of appellant. Each of these concepts were independent acts of invention.

The invention of the new heat-insulating structure was not an obvious or necessary result of the invention of the new aerogel substances. The new substances are made by a relatively costly process and the substances themselves are relatively expensive. The most nearly analogous substances in the prior art are the silica gels produced by drying gelatinous silica in the ordinary manner. These silica gels have been commercially available for a number of years, but no one has ever used them, or suggested them for use, as thermal insulation materials (App. p. 20).

It is earnestly submitted that there could be no truer act of invention than to conceive that the new substances, themselves invented by appellant, might provide in a heat-insulating structure a degree of insulation, not merely greater than any known substance, but greater than the accepted ideal of heat insulators. Appellant literally **invented the inconceivable.**

In the field of heat insulation, appellant has made a contribution of the same character as the electron microscope in the field of microscopy. Just as in the optical microscope it was "realized" that the wave-length of light set a definite lower limit to the resolving power of the microscope, so it was "realized" in the field of thermal insulation that the thermal conductivity of air set a lower limit to the insulating value of insulating materials. In the case of the electron microscope limitation of ordinary light was eliminated by substituting beams of electrons. In the field of insulating materials, appellant conceived that the properties of the air itself could be altered if the structure of the substance containing the air were so fine that the air molecules could not longer traverse their normal path without interference.

Neither the intellectual stature of appellant's conception nor the surprising effect on the experts in the art of its reduction to practice can be denied, and the Commissioner of Patents made no effort in the Court below to deny them. He has contended, in effect, that appellant's existing patent on the new substances and methods of making them is enough.

THE INVENTION IS NOT CLAIMED IN APPELLANT'S PATENT.

The critical finding of fact of the District Court is that "the claims in suit define no invention over the Kistler patent, No. 2,093,454". If this finding means that the invention defined in the claims is disclosed in the Kistler patent, the finding is correct in fact, but such a finding does not justify the conclusion that the claims are unpatentable.

It is well settled law that the disclosure of a copending application of the same inventor does not bar the allowance of claims to the disclosed invention in another application. As the Court of Customs and Patent Appeals said in *In re Germantown Trust Co.*, 57 F. (2d) 365:

> "Appellant's own patent is, of course, pertinent only to the extent of its claims, as showing what subject matter has already been patented to appellant".

In *General Tire and Rubber Co.* v. *Fisk Rubber Co.*, 104 F. (2d) 740, at page 745 (certiorari denied 308 U. S. 581), the Circuit Court of Appeals of the Sixth Circuit said:

> "Midgley's earlier patent No. 1,509,365, September 23, 1924, assuming that it contained disclosures found in his later patent, is not to be considered prior art for

> purposes of determining invention, since both patents were applied for by the same inventor and were copending before issued."

Analysis of the claims of appellant's patent clearly shows that the invention of the appealed claims is not the same as the invention covered by the claims of the patent. Claims 9, 10 and 12 to 23 of the patent define a new type of substance. Claims 1 to 8 and 11 of the patent define methods of making the new substance. None of the claims are directed to a heat-insulating structure or to a method of making such structure.

It is erroneous to contend that the inventive possibilities of a situation are exhausted when the first step is taken and patented. The history of the various arts demonstrates the fallacy of that contention. A striking example is found in the phenol-formaldehyde resins invented by Dr. Leo H. Baekeland. The primary invention of this new group of substances opened up a wide field for further invention both for Dr. Baekeland himself and for a large number of subsequent workers in this field. And, as Judge Chatfield said in *General Bakelite Co.* v. *General Insulate Co.*, 276 F. 166, at page 184:

> "Baekeland could also obtain valid patents for a varnish, for an indurated material and method for the making of a solid substance out of impregnated or filled cellular tissue, for obtaining a simple and desirable reaction product by the use of small amounts of accelerating base, or by the use of ammonia if in each of these patents his claim for invention depended on the recognition by him of the processes and principles which he had discovered and which had not been described in the prior art.
>
> "A separate patent application for each of these processes or products could be successfully maintained in the Patent Office and separate patents could issue thereon, if these applications were copending."

The Examiner and the Board of Appeals relied largely on the decision of the Court of Customs and Patent Appeals in *In re Byck*, 48 F. (2d) 665, in their rejection of the claims on appeal. It is submitted, however, that the situation in the Byck case was not the situation presented by this appeal. Byck had invented a new varnish composition for the production of electrically insulating and flexible films and had been granted a patent on his new compositions. In his copending application which was before the Court of Customs and Patent Appeals, Byck claimed an insulated coil comprising a conductive winding coated with the composition of his patent.

The court held that he was not entitled to claim in a separate patent the intended use of the composition which he had already patented. As the court said, Byck "had already received a patent for the only invention that was disclosed in either application".

In the Kistler patent, on the contrary, appellant disclosed a plurality of inventions of different categories and in different fields of art. In his first application he claimed, and was granted claims to, only his new material and the method of making it. He did not receive a patent on the new insulating structures of the present application.

As the Board of Appeals in its decision in the present application said:

> "It was recognized in the Byck case that there are instances where a patentee of a product may be entitled to further patents for uses of the products which are unobvious".

What stronger an instance than the present application could be imagined where the new use was not only unobvious but resulted in a type of heat insulation heretofore agreed by the experts in the art to be unattainable?

The production of a new heat-insulating structure was not the purpose of the invention claimed in appellant's patent. The list of possible uses of the new substances given in the patent itself is proof of this. The list of actual uses, entirely unconnected with heat insulation, given by the witness White (App. pp. 14-15) is further proof. The invention of the new heat-insulating structure was, in a sense, a by-product, but in no sense the primary purpose, of the invention of the patent.

Kistler did not undertake his line of study for the purpose of making inventions. He was concerned primarily with acquiring more knowledge about the universe we live in by studying the structure of the new matter he had developed. It may be that in the end the scientific data which he obtained may be of greater importance to mankind than the practical use we are here concerned with. But he did, in the midst of his scientific work, conceive these practical uses and gave them to the world in practical form and for these useful applications of his discoveries he is clearly entitled to patent protection.

SUMMARY AND CONCLUSION.

The conclusion of the District Court that the claims on appeal are unpatentable over appellant's patent is erroneous. The claims define an invention which is not claimed in the patent and which is an inventive contribution to the art of heat insulation.

Appellant has added to the resources of mankind a new heat-insulating structure having possibilities of unpredictable effect on the comfort and health of the post-war world. He has done this by the exercise of the highest order of intelligence. To deny him a patent on the practical applications of his contribution because in his application or patent on his first and distinct invention he likewise disclosed the present invention, would be an act of injustice and concontrary to the principles of the patent law.

Wherefore, appellant urges that the judgment of the District Court be revised and reversed.

Respectfully submitted,

Harold T. Stowell,
Attorney for Appellant.

J. Russell Wilson,
Of Counsel.

APPENDIX

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IN THE

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA.

No. 8517.

SAMUEL S. KISTLER, *Appellant,*

v.

CONWAY P. COE, COMMISSIONER OF PATENTS,
Appellee.

Appeal from the District Court of the United States for the District of Columbia.

APPENDIX TO BRIEF FOR APPELLANT.

I.

PLEADINGS, DOCKET ENTRIES AND OTHER PAPERS DESIGNATED BY APPELLANT.

1 Endorsed: Filed Dec 15 1941 Charles E. Stewart, Clerk.

In the District Court of the United States for the District of Columbia

Civil Action No. 13971

Samuel S. Kistler, West Boylston, County of Worcester, State of Massachusetts, *Plaintiff*,

v.

Conway P. Coe, Commissioner of Patents, Washington, D. C., *Defendant*.

Complaint to Secure Issuance of Patent

To the Honorable Judges of the District Court of the United States for the District of Columbia.

The plaintiff, for his complaint, alleges:

1.

That the jurisdiction of this Court depends upon the Statutes of the United States relating to the grant and issuance of Letters Patent of the United States, and particularly upon that certain section thereof known as R. S. 4915; U. S. Comp. Stat. 1916, Sec. 9460; U. S. C., title 35, sec. 63.

2 2.

That plaintiff, Samuel S. Kistler, is a citizen of the United States, and a resident of West Boylston, County of Worcester, State of Massachusetts.

3.

The defendant, Conway P. Coe, is the Commissioner of Patents of the United States, a resident of the State of

Maryland, whose official residence as Commissioner of Patents is in the District of Columbia, and he is sued as Commissioner of Patents of the United States.

4.

That plaintiff, Samuel S. Kistler, did invent certain new and useful improvements in Thermally Insulated Structures and Method of Making Same, for which invention an application for Letters Patent of the United States was filed in the United States Patent Office on April 8, 1937, entitled "Thermally Insulated Structures and Method of Making Same", which application was given the Serial No. 135,801.

5.

That said application was filed in accordance with the Laws of the United States and with the Rules of Practice of the Patent Office.

6.

That said application has been duly prosecuted in accordance with the Laws of the United States and with the Rules of Practice of the Patent Office.

3

7.

That a patent on the aforesaid application has been refused by the Commissioner of Patents, defendant herein.

8.

That the invention involved in this proceeding relates to a method of thermally insulating structures by providing an enclosed space substantially surrounding the structure and filling the space with an inorganic aerogel, such as silica aerogel, and to the thermally insulated structures thereby produced.

9.

That said application has been passed upon by the Primary Examiner who refused to allow any of the claims of said application, and that the Primary Examiner finally rejected the following claims:

1. A thermally insulated structure comprising, at least, two spaced walls having an inorganic aerogel disposed in the space therebetween as a thermal insulator.

2. In an insulated structure having heated material in the interior thereof, said insulated structure comprising spaced walls surrounding the heated material, at least in part, the space between said walls being filled with an inorganic aerogel in intimate contact with the surfaces of said walls.

4 3. In an insulated structure having cooled material in the interior thereof, said insulated structure comprising spaced walls surrounding the cooled material, at least in part, the space between said walls being filled with aerogel in intimate contact with the surfaces of said walls.

4. An insulated structure comprising, at least, two spaced walls having an inorganic aerogel disposed in the space therebetween and in contact with said walls, the inorganic aerogel being in sufficiently fine state of sub-division to give it flowing properties whereby it may be poured into the space between the walls.

5. An insulated structure comprising, at least, two spaced walls having silica aerogel disposed in the space therebetween and in contact with said walls, said aerogel being in sufficiently fine state of sub-division to occupy substantially all of the space between the walls.

6. The method of thermally insulating structures which includes the steps of providing an enclosed space substantially surrounding the structure and filling the space with silica aerogel in a sufficiently fine state of subdivision to flow into said space.

5 7. The method of thermally insulating structures which includes the steps of providing an enclosed space substantially surrounding the structure, filling the space with silica aerogel in a sufficiently fine state of subdivision to flow into said space, and sealing said space.

8. The method of thermally insulating structures which include the steps of providing an enclosed space substan-

tially surrounding the structure, filling the space with silica aerogel, evacuating said space and then hermetically sealing the same.

9. A thermally insulating container comprising inner and outer shells of similar shape, the inner shell being of less dimension than the outer shell and supported out of contact with the walls of the outer shell, aligned openings in said shells, a wall of insulating material extending between the edge portions of said openings, silica aerogel disposed in and filling the space between said inner and outer shells, a shelf disposed in the inner shell and supported between the upper and lower ends thereof, the space below the shelf being adapted to contain a refrigerant and the space above the shelf being adapted to support the substances to be kept cooled, and a cover for said openings.

6 13. A thermally insulated structure comprising at least two spaced walls having pulverized, substantially incompressible, free-flowing silica aerogel disposed therebetween as a thermal insulator and substantially filling the space between said walls and means for preventing the leakage of a substantial portion of the free-flowing aerogel from between said walls under normal conditions of handling and use.

14. A thermally insulated structure comprising at least two spaced walls having pulverized, substantially incompressible, free-flowing silica aerogel disposed therebetween as a thermal insulator and substantially filling the space between said walls and forming a support therefor, and means for preventing the leakage of a substantial portion of the free-flowing aerogel from between said walls when the latter are compressed toward each other by an exterior force.

10.

That from the decision of the Primary Examiner an appeal was taken to the Board of Appeals of the United States Patent Office, which affirmed the rejection of the Primary Examiner in its decision dated June 17, 1941; and that no appeal has been taken to the United States Court of Customs and Patent Appeals from said decision.

7 11.

That the invention is new and useful and was not known or used by others in this country before the invention thereof by said Samuel S. Kistler, and was not patented or described in any printed publication in this or any country before the invention thereof by said Samuel S. Kistler, or more than two years prior to his said application for patent therefor, and not in public use or on sale in the United States for more than two years prior to said application, and not patented in any country foreign to the United States on an application filed by said plaintiff, Samuel S. Kistler, or his legal representatives or assigns more than twelve months prior to said application for United States Letters Patent, and has not been abandoned.

Wherefore, the plaintiff prays:

I. That this Honorable Court adjudge that plaintiff, Samuel S. Kistler, is entitled according to law to receive Letters Patent of the United States for the aforesaid invention as defined in claims 1 to 9, 13 to 14, hereinbefore recited.

II. That this Honorable Court decree that the Commissioner of Patents be directed to allow the aforesaid claims 1 to 9, 13 and 14, and such other claims as upon hearing the Court may find patentable, and to issue to plaintiff, Samuel S. Kistler, United States Letters Patent containing said claims.

8 III. For such other and further relief as the nature of the case may require and as to this Honorable Court may seem meet.

SAMUEL S. KISTLER
By HAROLD T. STOWELL,
Attorney for plaintiff,
1319 F Street, Northwest
Washington, D. C.,
Phone: Metropolitan 1147.

Of Counsel:

J. RUSSELL WILSON,
St. Louis, Missouri.

Washington, D. C.
December 15, 1941.

* * * * * * * * * *

9 *Answer to the Complaint.*

To the Honorable the Justices of the District Court of the United States for the District of Columbia.

1, 2, 3. Defendant admits the allegations of paragraphs 1, 2 and 3.

4. He admits that plaintiff, claiming to be the inventor of certain new and useful improvements in "Thermally Insulated Structures and Method of Making Same", filed in the Patent Office, on April 8, 1937, an application for patent thereon, to which application Serial No. 135,801 was given. He denies that the subject matter of said application constitutes a patentable invention.

5, 6, 7, 8. He admits the allegations of paragraphs 5 to 8, inclusive.

10 9. He admits that said application was passed upon by the primary examiner, who refused to allow any of the claims thereof, and that the primary examiner rejected claims 1 to 9, inclusive, 13 and 14 of said application, which claims are as set out in paragraph 9, except that in claim 8 the last word should be space.

10. He admits the allegations of paragraph 10.

11. He admits that in said application plaintiff made averments corresponding to the allegations of paragraph 11, but denies that such allegations are sufficient to justify the issuance of a patent containing any of said claims 1 to 9, inclusive, 13 and 14 of said application, as it is deemed that the said claims are unpatentable in view of the following prior patents and for the reasons given in the statement of the examiner in answer to the appeal and the decision of

the Board of Appeals, copies of which will be furnished at the trial:

Stanley, 1,071,817, September 2, 1931,
Schellens, 2,038,763, April 28, 1936,
Kistler 2,093,454, September 21, 1937.

Profert of copies of these patents is hereby made.

W. W. COCHRAN,
Solicitor, U. S. Patent Office,
Attorney for Defendant.

December 29, 1941.

I hereby certify that a copy of this ANSWER TO THE COMPLAINT was mailed today, December 29, 1941, to the attorney for plaintiff, Harold T. Stowell, 1319 F Street, N. W., Washington, D. C.

W. W. COCHRAN,
Solicitor.

50

Findings of Fact

1. This is an action brought under the provisions of Section 4915 R. S. (U. S. C. title 35, sec. 63) in which the plaintiff, Samuel S. Kistler, sought to have this Court adjudicate that he is entitled to have issued to him a patent on his application, No. 135,801, filed April 8, 1937, containing claims 1 to 9, inclusive, 13 and 14.

2. The Kistler application relates to thermally insulated structures and to a method of forming the same. More specifically, the application discloses a structure formed with walls spaced apart, the portion between the walls being filled with a thermally insulating material. This material is referred to as silica aerogel, which is the material described and claimed in applicant's patent, No. 2,093,454, issued September 21, 1937, on an application filed October 1, 1934.

3. The patent to Stanley, No. 1,071,817, discloses a heat insulated receptacle formed of walls spaced apart, with the

space between the walls filled with an insulating material.

51 4. The patent to Schellens, No. 2,038,763, discloses a heat insulating food container in which the space between the walls of said container is filled with a heat insulating material.

5. The Kistler patent, No. 2,093,454, discloses a process for making a dry aerogel and the material itself, which is referred to as a silica aerogel. This patent describes the material as having a high thermal insulating power, and claims 18 and 19 of the patent specify as a quality of the gel claimed that it is characterized by high thermal insulating power.

6. It was not further invention for the applicant to use the material of his patent as an insulating material for thermally insulated structures.

7. The claims in suit define no invention over the Kistler patent, No. 2,093,454.

Conclusions of Law

1. The plaintiff is not entitled to a patent on his application, No. 135,801, containing claims 1 to 9, inclusive, 13 and 14, or any of them.

2. The Complaint should be dismissed with costs against the plaintiff.

DANIEL W. O'DONOGHUE

Mch. 1st, 1943 *Justice*

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52 *Judgment*

This cause having come on to be heard and having been tried in open court and argued by counsel for the respective parties upon the pleadings and proofs adduced and submitted to the Court, It is Adjudged, this 1st day of March, 1943, that the complaint in this case be, and the same hereby is dismissed with costs against the plaintiff.

DANIEL W. O'DONOGHUE
Justice

Approved as to Form:
HAROLD T. STOWELL
Attorney for Plaintiff

• • • • • • • • • •

13 Washington, D. C.
Monday, January 25, 1943.

The above-entitled cause came on for trial before Associate Justice Daniel W. O'Donoghue, in Civil Division, at 11 o'clock a. m.

Appearances:

On behalf of the Plaintiff:
Harold T. Stowell,
Ralph E. Parker.

On behalf of the Defendant:
R. F. Whitehead.

14 *Evidence on Behalf of Plaintiff*

Thereupon John F. White was called as a witness for and on behalf of the plaintiff and, having been first duly sworn, was examined and testified as follows:

Direct Examination

By Mr. Stowell:

Q. State your name, age, and residence, please. A. John F. White, 35 years old. I reside at 9 School House Road, Medford, Massachusetts.

Q. What is your present position? A. I am a group leader in the Research Department of the Merrimac Division of Monsanto Chemical Company.

Q. Will you briefly outline your technical education and professional experience? A. I passed through the elementary and high school of Cambridge, Massachusetts. I studied general chemistry, qualitative and quantitative chemistry, at Massachusetts Institute of Technology during the summers of 1926 and 1927. I studied colloid chemistry at the same institution under Dr. Hauser during the summer of 1938.

My working experience has been as chemist at the Massachusetts General Hospital during the years of 1926 and 1927. I entered the employment of the Merrimac Chemical Company in 1927 as a research chemist. The Merrimac Chemical Company was taken over by the Monsanto Chemical Company in 1929, so that I was transferred to the Monsanto Chemical Company at the same time, and I have been in their employment ever since.

During that time I have carried out many research projects, and in 1935 the development of silica aerogel into a commercial proposition was assigned to me, and that has been my principal work since 1935: that is, my work and that of the group under me. During that time we had to study not only the methods of manufacture, that is, the best method, but the best uses to which the material might be put. During that work we made several hundred determinations of thermal conductivity of aerogel and also of other materials.

Q. I think that will be plenty, Mr. White. Are you familiar with the Kistler application serial No. 135,801? A. Yes.

Q. Will you describe briefly the invention disclosed in that application? A. The invention in that application describes the assemblies, thermally insulated assemblies, these assemblies being made up of two spaced walls, the spaces between those walls being filled with aerogels, or more specifically silica aerogel.

Q. What are aerogels? A. Aerogels are a new form of matter invented by Dr. Kistler.

Q. Are they the products described by this name in
16 the Kistler United States Patent 2,093,454? A. Yes.

Q. Will you state briefly what they are? A. Aerogels are substances made by dehydrating gelatinous substances in such a manner that the solid phase—that is, the solid portion—of the gel undergoes no substantial change during that drying or removal of that liquid phase.

Q. How may that removal be accomplished, attained? A. It is accomplished by heating the gel up to such a temperature that the liquid phase present in the gel has little or no surface tension and so its withdrawal from the system does not cause any destruction of the solid phase.

Q. Can this be done by ordinary drying methods? A. No; the ordinary drying methods, when they are employed, cause the gel to shrink very considerably and result in a rather hard, horny, or glasslike mass.

Q. In this Kistler method how is that structural change of the solid phase avoided? A. In the Kistler method the gel from which the liquid phase is to be removed is charged to a pressure vessel and heated up in that pressure vessel under such pressures that no substantial volatilization of the liquid phase occurs. It is heated up under those conditions, then, to or above the critical temperature of the liquid phase present, and once that temperature has been attained it is maintained, and the vapor in the autoclave is withdrawn.

Q. What is the critical temperature of a substance? A. The critical temperature of a substance is that temperature at or above which the substance may no longer exist as a liquid regardless of the pressure applied to that sub-
17 stance.

Q. Are you familiar with the actual manufacture of aerogels in accordance with the Kistler invention? A. Yes.

Q. Will you briefly outline the manufacture of a typical aerogel? A. Well, a typical aerogel is the silica aerogel. That is made from sodium silicate, commonly known as water glass. A dilute solution of the sodium silicate is reacted with a dilute solution of an acid, and the mixture of those solutions sets to a firm transparent gel. The gel so formed is crushed up into small lumps, washed with water to remove the salts that are formed during the initial reaction, and it is then washed with alcohol, the purpose of the alcohol washing being to substitute alcohol for the water that was originally in the gel, and that substitution can be done without any visual change taking place in the gel. The alcogel formed by that washing method is then charged to an autoclave, a pressure vessel, and heated up to above the critical temperature while maintaining a pressure in excess of the critical pressure; and when the critical temperature has been reached the alcohol is withdrawn from the autoclave while that critical temperature is still maintained.

Q. What is the purpose of replacing the water by the alcohol in this original gel? A. The critical temperature and pressure of water are very high. By substituting alcohol for the water it makes it permissible to operate at much lower temperatures and pressures.

Q. What is the nature of the product resulting
18 from this autoclaving operation? A. The material
so formed is light. It is light because there is very
little shrinkage, and furthermore it is semitransparent and somewhat elastic and resilient.

Q. Is this a sample of the material that is obtained from the autoclave? (Indicating) A. Yes, it is.

Mr. Stowell. The sample which the witness has identified is offered in evidence as Plaintiff's Exhibit 1.

(Bottle of material labeled "Silica aerogel, lump," was marked Plaintiff's Exhibit 1 for identification and received in evidence.)

By Mr. Stowell:

Q. Is this the finished product (indicating)? A. Well, usually for most applications that material is finely ground.

Q. Is this the sample of the ground product? A. Yes, that is.

Mr. Stowell. This sample of the ground product is offered in evidence as Plaintiff's Exhibit 2.

(Bottle of material labeled "Silica aerogel, fines," was marked Plaintiff's Exhibit 2 for identification and received in evidence.)

Mr. Stowell. If your honor please, you will find that that is really a most interesting substance, if you care to feel of it. It is not like anything that I have ever seen before. Just put your finger in it. It gives you the impression of something really fine. You will find it of interest.

The Court. It will pour.

19 Mr. Stowell. It is perfectly solid glass, in a sense. It has all the feeling of a liquid in spite of the fact that it is a solid material.

By Mr. Stowell:

Q. Will you briefly outline some of the uses of this silica aerogel? A. There have been commercial uses that have been developed. Perhaps the most outstanding use aside from insulation is to impart a mat finish to lacquer films. That is sometimes referred to as a flat film. Lacquer films—that is, nitrocellulose lacquer films—are usually very glossy; but with some of the silica aerogel ground into the vehicle, films so formed—that is, formed from such a composition—become quite dull in appearance, and the specular reflection from such films is greatly reduced. That particular use has come to be of very considerable importance in the present war program. The material is used in the camouflage films on some of the apparatus used by the forces.

Q. Because it cuts down light reflection? A. Because it cuts down the specular reflection from those surfaces.

The other uses: It can be used as an antitack agent. For example, when certain types of raincoats or such fabrics are folded up and put in cases for shipping, the folds of the cloth tend to stick. If such articles are dusted with this

material, that tacking tendency is eliminated. And stencil lacquers, which are very heavy, must be heavy for use; they are very stringy. That is, when the stencil is pulled away from the surface, strings will be left behind
20 which mar the design. If the aerogel is incorporated in such material, the lacquer goes from what is known as a long lacquer to a short lacquer. That is, the tendency to string is reduced.

It is also used for viscosity control. In many coating compositions the pigments or film-forming bodies in solution are not sufficient to give to that solution a viscosity proper for spraying or other methods of application. Small amounts of the aerogel ground into such vehicles increase their viscosity so it is possible to get viscosity increase or control. Also, in coating compositions that are pigmented, pigments tend to settle out into the bottom of the container and become cementlike masses there. The aerogels in such a vehicle do not prevent the settling, but they prevent the pigment from cementing together.

Powdered materials. There are many powdered materials which are somewhat hygroscopic, or on standing tend to absorb or adsorb water from the atmosphere, and that in turn causes the powder to cement together. As little as a tenth of a thousandth of this material mixed with those powders will prevent that cementing together.

There are other powders which might be completely dry, and yet, because of the particle size or, rather, shape, they do not flow freely. As little as one or two tenths of a thousandth of an aerogel in that mass will cause it to flow very freely.

It is also used in printing ink for viscosity adjustment and as an antipenetrant. When printing inks are applied to paper, the liquid part of the vehicle penetrates into the paper. The aerogel is retained on the surface of the paper, and it in turn helps to retain the pigment of the ink
21 on the surface of the paper, so that one gets a more level print and at the same time gets a better efficiency of the pigments in the ink.

Aside from these uses it is also used for a thermal insulating mass, in accordance with the—

Q. (Interposing) All of these units except the last, as I understand them, are entirely distinct from the thermal insulation use. A. Oh, yes; they are all distinct uses.

Q. They have no connection with thermal insulating properties that we are dealing with here? A. None whatever.

Q. From a chemical point of view, Mr. White, what substance would be expected to be most nearly analogous to silica aerogel? A. Well, silica gel made by the dehydration of silica hydrogel in the normal way.

Q. Is that a commonly known substance? A. It is a commercial material.

Q. A commercial product available on the market? A. Yes.

Q. Have you ever heard of silica gel used or proposed to be used as a heat insulating material? A. No.

Q. Have the heat insulating properties of silica gel been tested? A. To the best of my knowledge they were tested recently by Professor Wilkes of Massachusetts Institute of Technology. His tests were conducted upon a sample of
silica gel that I procured for him from the Davison
22 Chemical Corporation of Baltimore; they are the
commercial manufacturers of this material.

Mr. Stowell. If your Honor please, I would like permission to interrupt the testimony of Mr. White at this time to put on Prof. Wilkes: I think the presentation would be a little more logical and understandable on that basis; and then recall Mr. White later on.

The Court. All right.

(The witness left the stand.)

Mr. Stowell. Professor Gordon B. Wilkes.

Thereupon **Gordon B. Wilkes** was called as a witness for and on behalf of the plaintiff and, having been first duly sworn, was examined and testified as follows:

Direct Examination

The Assistant Clerk. State your full name, Mr. Wilkes.

The Witness. Gordon B. Wilkes.

By Mr. Stowell:

Q. State your age and residence. A. Age 53, and I live at 51 Everett, Newton Center, Mass.

Q. What is your present position? A. My present position is professor of heat engineering at Massachusetts Institute of Technology, Cambridge, Mass.

Q. Will you state briefly your technical education and professional experience? A. I graduated from the Massachusetts Institute of Technology in 1911 with a degree of bachelor of science in mechanical engineering. Ever
23 since that time I have been connected with the Institute. For 23 years I was in the physics department going through various grades of instructor, assistant professor, and finally as professor of industrial physics. About 1934 I was made professor of heat engineering in the mechanical engineering department. During that time I was always connected with the heat measurements laboratory, for the last 15 years or so in charge of that laboratory. One very large portion of the work in that laboratory is connected with the measurement of the thermal conductivity of various materials, heat transfer coefficients.

Q. You have determined the thermal conductivity of many insulating materials, then? A. Yes.

Q. How is the thermal insulating value of a material commonly expressed, Doctor? A. It is commonly expressed by engineers as the B.T.U.'s that are transferred through a square foot in one hour for one inch of thickness and for each degree Fahrenheit difference in temperature. The chemical engineer uses a unit one-twelfth of this value because he uses the foot thickness rather than the inch thickness.

Q. Now, that unit that you have defined is the unit which is commonly known as the K factor, isn't it? A. That is correct.

Q. I hand you a print marked "Lange's Handbook of Chemistry, 2nd Edition, 1937. Pages 622 to 625." Is this a representation of the table of physical and thermal properties of heat insulating materials from pages 622 to
24 625 of that handbook? A. Yes.

Q. Where does the K factor appear in this table? A. In the second column, under "K".

Mr. Stowell. That would be item 6 in your Honor's file. The print is offered in evidence as Plaintiff's Exhibit 3.

(Print of pages 622 to 625, Lange's Handbook, was marked Plaintiff's Exhibit 3 for identification and received in evidence.)

By Mr. Stowell:

Q. I hand you a print marked "Mark's Mechanical Engineers' Handbook, 4th Edition, 1941". Are the tables on this print reproduced from pages 394 and 395 of that handbook? A. Yes.

Q. Do these tables differ from those in Lange's Handbook of Chemistry? A. In this respect: The K values are the chemical engineer's units. That is, the values would be one-twelfth of those given in the Lange's Handbook. Also, these tables show the effect of temperature on the K value.

Mr. Stowell. This photoprint is offered in evidence as Plaintiff's Exhibit 4.

(Print of pages 394 and 395, Mark's Handbook, was marked Plaintiff's Exhibit No. 4 for identification and received in evidence.)

By Mr. Stowell:

Q. Are you familiar with Circular No. 376 of the United States Bureau of Standards, published October 17, 1929, and entitled "Thermal Insulation of Buildings"? A. Yes.

25 Q. Is this a copy of that publication (indicating)? A. Yes.

Q. I call your attention to the following statement on page 4 of the circular.

Your Honor will find a copy of page 4 as item No. 8 in the file.

"Since every known solid material has a greater thermal conductivity than air, it is evident that the conductivity of air fixes the lower limit of the conductivity of insulating materials containing air."

Did this statement represent the common opinion of heat insulation experts at the time the circular was published? A. Yes.

Q. What does Figure 2 on page 6 of this circular represent? A. That represents the equivalent thickness of common insulating materials compared to air, which is called the ideal insulation.

Mr. Stowell. The circular of the Bureau of Standards, No. 376, is offered in evidence as Plaintiff's Exhibit 5.

(Circular of the Bureau of Standards, No. 376, was marked Plaintiff's Exhibit No. 5 for identification and received in evidence.)

By Mr. Stowell:

Q. Are you familiar with the material known as silica aerogel? A. I am.

Q. How did you first become acquainted with silica
26 aerogel? A. The first material that I actually had
was given to me by Monsanto Chemical Company for
determination of its heat conductivity.

Q. Did you test this material? A. Yes.

Q. With what results? A. The results were astonishing and almost unbelievable.

Q. Why were they so astonishing? A. It was the first material that had a value of K less than that of air, which heretofore had been the ideal insulator.

Q. You made a large number of determinations of the thermal insulating value of silica aerogel, did you? A. Yes, I made a very considerable number of determinations of it.

Q. And you are perfectly satisfied that that K factor which is so astonishing, in view of the previous opinions limiting the ideal value to that of still air, is correct? A. Yes, I feel very certain of that fact.

Q. Did you have any doubts about the K factor when you first determined it, Professor? A. Yes. I believed, along with all other heat experts, that there was no material that would be better than—have a lower K value than—air. So when we made our first determination and found the value was lower than that of air, we went over our apparatus, actually rebuilt it in some respects, so as to eliminate any possibility of doubt, and we got the same results: it was still definitely better than air.

Q. What is the accepted K factor for still air? A. 0.173 at a temperature of 109 degrees Fahrenheit. It varies with the temperature, of course. 27

Q. What is the K factor of silica aerogel as you have determined it? A. The average of some 32 tests that have been made over the last six years gives a K value of 0.158 at a mean temperature of 109 degrees Fahrenheit.

Q. Have you determined the heat conductivity of the material known as silica gel? A. Yes.

Q. What result did you obtain? A. We obtained a K value of 0.59, which is nearly four times that of the silica aerogel.

Q. Now, where did you obtain this silica gel that you have testified to? A. That was delivered to me by Mr. White of the Monsanto Chemical Company.

Q. Have you ever heard of silica gel being used or proposed for use as a heat insulating material? A. No, sir.

Q. What is the K factor of asbestos fibers? A. It varies anywhere between 0.4 and 1.4 according to density and temperature.

Q. What is the K factor of diatomaceous earth? A. The K factor of diatomaceous earth will vary between 0.3 and 0.7 according to density.

Q. In United States patent 1,071,817 to Stanley, the patentee refers to a material by the name of "sublimed silica". Do you know what this material is? A. I don't know

28 of any commercial material that is sold as "sublimed silica".

Q. I hand you a chart. I will ask the Clerk to mark that for identification Plaintiff's Exhibit 6.

(A chart was marked Plaintiff's Exhibit No. 6 for identification)

By Mr. Stowell:

Q. What does this chart represent?

Your Honor, that will be item 10 in your Honor's file.

A. This chart represents the equivalent thickness of common insulating materials that equals one inch of ideal insulation. The ideal insulation is colored blue on this chart. This is taken from that Bureau of Standards circular. In addition to that there has been added the equivalent thickness of silica aerogel, which is colored pink on this chart, which shows the equivalent thickness of silica aerogel.

Q. Aside from the addition of the color and the adding of a representation of the position of the silica aerogel, is this chart identical with Figure 2 in the Bureau of Standards circular? A. Yes.

Q. And does the chart of this exhibit represent, in your opinion, the true relative position of silica aerogel with respect to the common insulating materials? A. Yes.

Mr. Stowell. The chart which the witness has just identified is offered in evidence as Plaintiff's Exhibit 6.

(Chart, heretofore marked Plaintiff's Exhibit 6 for identification, was received in evidence.)

29 By Mr. Stowell:

Q. When you first tested silica aerogel you had never tested or heard of any material having a heat insulating value as low as that of still air; is that correct? A. That is correct.

Q. What is the lowest K value known for any common commercial insulating material other than silica aerogel? A. About 0.23.

Q. In your opinion, is this difference between the insulating properties of silica aerogel and the other materials, as expressed, for example, on that chart, merely a difference of degree? A. No. This is the first material that has a thermal conductivity lower than that of still air. It is in a distinct class by itself.

Q. How could such a result be explained? A. The explanation is that the pores of this material are so fine that they restrict the molecular movement of the air, the transfer of heat by the molecules of the air, and consequently actually reduce the conductivity of the air.

Q. And prior to this material no insulating material known to you had ever shown any signs of having that effect; is that right? A. No; that is correct.

Mr. Stowell. That is all. You may cross-examine.

Mr. Whitehead. No cross-examination.

(The witness left the stand.)

Thereupon **John F. White** was recalled as a witness for and on behalf of the plaintiff and, having been previously duly sworn, was examined and testified further as follows:

Further Direct Examination

By Mr. Stowell:

Q. Are you familiar, Mr. White, with the technical and commercial development of the new heat insulated structures of this invention? A. Yes, I am.

Q. What is the most striking advantage of the heat insulated structures of the invention as compared with the heat insulated structures of the prior art? A. The most striking difference is that a much thinner layer of aerogel can be used to obtain a given thermal efficiency, and by making use of that fact it is then permissible to construct thermally insulated chambers of good thermal efficiency but with smaller outside dimensions than hitherto possible.

Q. Is this sketch an illustration of that (indicating)? A. Yes, it is.

Mr. Stowell. That is item 11 of your Honor's file.

By Mr. Stowell:

Q. Will you please explain briefly the meaning of the structures shown in this sketch, Mr. White? A. Figure 1A represents the cross section of a standard commercial refrigerator. Actually this is the Coldspot refrigerator, a
well known refrigerator, and made by Sears, Roe-
31 buck Company. As is shown here, as it is convention-
ally, it has an insulating layer 2.8 inches in thickness.
Now, that box—that is, the inner liner of that box as shown by Figure 1B—has a total gross volume of 6.55 cubic feet.

Figure 2A is a cross section of the revised or redesigned Coldspot refrigerator in which Santocel, silica aerogel, was used for the insulation. The thickness of the silica aerogel used was 1.8 inches.

In this assembly—that is, 2A and 2B—the outer case was left untouched. So by using a thinner layer of the aerogel insulation we were able to get in there a liner that had a total gross volume of 9½ cubic feet. That is, now both of these cabinets—that is, we will say 1B cabinet and 2B cabinet—were tested for their thermal efficiencies, and those tests indicated that the thermal efficiencies were the same. Both cabinets have the same outside—that is, exterior—dimensions, but the cabinet insulated with the silica aerogel has a food storage volume of 9½ cubic feet as compared to the 6½ cubic feet in the original cabinet. That is, the substitution of the aerogel for the previously used insulator permitted approximately a 45 per cent increase in the storage capacity of that refrigerator.

Q. In other words, taking the standard commercial refrigerator, without increasing its size, its external dimensions, you can expect to get in the neighborhood of 50 percent increase in useful food storing space, for example? A. Yes, something like that. All domestic—that is, stand-

ard domestic—refrigerators, the volume of insulation used
in those refrigerators is always about equal to the
32 volume of the food storage capacity; so that if one
were to substitute an insulation having double the efficiency—that is, use that figure roughly, an efficiency double that of the previously used one—then it should be possible to get an increase of something like 50 percent in the interior volume.

Q. What is the term "Santocel" that appears on this drawing? A. Well, that is a trade-mark used by the Monsanto Chemical Company to identify aerogel products.

Mr. Stowell. The drawing is offered in evidence as Plaintiff's Exhibit 7.

(Sheet of drawings was marked Plaintiff's Exhibit No. 7 for identification and received in evidence.)

By Mr. Stowell:

Q. Does the silica aerogel have any other properties, in addition to the low heat conductivity, which render it particularly valuable in heat insulated structures? A. Yes. It is light in weight, and it is also free-flowing and has a certain amount of elasticity or resiliency.

Q. Why is its elasticity of importance? A. In refrigerator cabinets the cabinets are apt to be located in a room where there is a certain amount of temperature variation; and because of this temperature variation the shell of the cabinet is apt to expand or contract. The insulation lying under that cabinet, if it is elastic, will come and go with the change in dimension of the outer case, so that no voids or holes will be formed in the insulating space by such action if that insulation is elastic.

33 Q. It is noted that in handling the bottle containing
the sample of Exhibit 2 the material flows back and forth in the bottle almost like liquid. That is a rather unusual property of any material, isn't it, to have such free-flowing characteristics? A. Well, it is an unusual property of this material; its flowability is striking.

Q. Is that property of importance too in its use as a heat insulator? A. Oh, yes. It can be poured into the insulation space, and because it flows freely it will go into all the corners and crevices of that chamber, and so it minimizes the danger of getting unfilled spots within the cabinet. It also fits well into the mass production method of assembling refrigerators. Usually a manufacturer, one manufacturer, will produce something like three or four different sizes or styles of cabinets; and if he uses insulation in bat form he will find it necessary to keep a stock of something like 18 to 20 or more—it is a vague number but a large number—of various sizes and shapes of insulation to fit all the corners and parts of those assemblies. Now, the use of a material like this avoids the necessity of stocking such a variety of materials. One storage bin only is necessary. Furthermore, because it flows freely into the cabinets, why, instead of a tedious hand job of applying these bats to various parts of the refrigerator, it is merely filled in; and so, as I say, it fits well into production work.

Q. What has been your experience, Mr. White, of the
attitude of heat insulation experts in general toward
34 this invention? A. The experts have been somewhat
reluctant to accept it as an insulator. The cost of
the material seems to blind them to its advantages. It is only after you can point out to those men the hidden—the advantages that do lie there, that they begin to see its potential uses.

Q. In spite of the fact that you call their attention to this very low and unusual—in fact, unique—K factor or heat insulating value, they still do not appreciate all the capabilities of this material in view of the high cost of producing it? A. That is right, yes.

Q. It is a relatively high-cost material; is that correct? A. As an insulating material it is in the upper brackets.

Q. Then, using this material to get the advantage of it is not merely a question of substituting aerogels for noninsulating materials; is that correct? A. No. In most cases to get the utmost advantage—that is, the real novelty of the material lies in the fact that the conventional types of equipment, such as household refrigerators and the like, require redesign to get the utmost out of the material. There are cases, of course, where the substitution of the aerogel for another insulator in an existing design does permit results to be obtained that probably couldn't be obtained in any other manner.

Q. Can you describe such a situation? A. Yes, I have had contact with one such situation. A manufacturer is producing units for the purpose of storing food, frozen food, at temperatures of zero Fahrenheit or even lower, these foods to be stored over a long period of time. on the design of such an assembly there are two conditions that must be met.

First, the unit—that is, the storage volume—must be of a practical size. If it is too small nobody is interested in it, and a good practical size would be, well, not less than four cubic feet. Also, that storage volume should be of what you might term a practical shape. It must approach a cube in its dimensions. That is, long and deep, narrow compartments are not suitable. And the other condition is that the storage space must be surrounded with sufficient insulation to establish such a temperature gradient through the insulation that the outer shell is above the dew point of the atmosphere around it.

Now, the manufacturer had developed a novel method of refrigeration, and so forth, and he went into the business of manufacturing such units for domestic storage, but he found that these units frequently had condensation on the outside. He had four inches of insulation, and it was not adequate for the job. He couldn't expand the thickness of insulation. That is, using the same standard or conventional type of insulation he couldn't expand the thickness because if he did that the unit's dimensions would exceed that of a standard door, that is, of the doors used in homes; and since this unit was intended for domestic sale he had a very tough problem there.

Now, the replacing of insulation that he did use, replacing that with silica aerogel, permitted him then to establish the temperature gradient that prevented condensation on the outside, and so he really converted an unsalable assembly to one with definite sales appeal.

36 Q. Is that in commercial use now as you have described it? A. No. By the time that was worked out the war came along. The refrigerator market and materials are upset. And furthermore, during the working out of that problem other factors were found which had a direct bearing upon the industrial war effort; and since our capacity of manufacture isn't sufficient to take care of both domestic and industrial markets, why, it has been confined to the industrial use.

Q. What is that industrial use? A. When this manufacturer was testing the piece of equipment that he had insulated with aerogel he found in the course of his tests that the temperature of the equipment went to about minus 60 degrees Fahrenheit.

Now, when he had the previous insulator in there his lower limit was somewhere around minus 20. The fact that it went to minus 60 was interesting academically, and somewhat surprising too. It was a very low temperature for a mechanically operated refrigerator.

But he really didn't visualize any use for that, but he had the thing operating in his laboratory where quite a number of people had access to it. Salesmen coming in selling valve parts or things of that sort, saw the unit running. They too were interested in the unusually low temperature, but they went out again and made no remarks, but suddenly this manufacturer started receiving orders for this unit. It is the Deepfreeze unit. But the orders were qualified with the condition that it must be insulated with the Monsanto type insulation and it must be capable of going to
37 minus 60. These orders were coming from manufacturers, large manufacturing plants; and a follow-up on these orders developed that there was quite a need for

mechanically operated refrigerators throughout the industry. And as a result of that this man has gone ahead and is supplying a large number of industrial users now with this supercooled Deepfreeze unit.

Q. Can you identify this paper (indicating)? A. Well, that is an ad of a Deepfreeze unit containing Santocel, that appeared in the Fortune magazine.

Q. For what date? A. It would be on this (indicating). Oh, yes: in June of 1942.

Mr. Stowell. This advertisement is offered in evidence as Plaintiff's Exhibit No. 8.

(Deepfreeze ad, Fortune Magazine, was marked Plaintiff's Exhibit No. 8 for identification and received in evidence.)

By Mr. Stowell:

Q. Can you identify this paper (indicating)? A. This is an ad of the Deepfreeze Santocel unit appearing in the Journal of Commerce September 8 of 1942.

Mr. Stowell. The paper which the witness has just identified is offered in evidence as Plaintiff's Exhibit No. 9.

(Deepfreeze ad, Journal of Commerce, was marked Plaintiff's Exhibit No. 9 for identification and received in evidence.)

By Mr. Stowell:

Q. What is the paper which you now have? A. Why, this
is another advertisement of the Deepfreeze Santocel
38 assembly. It has been reprinted. This is a reprint of
such ad that appeared in several scientific or trade
journals.

Q. In November of 1942? A. Yes.

Mr. Stowell. We offer it in evidence as Plaintiff's Exhibit No. 10.

(Deepfreeze ad, reprint, was marked Plaintiff's Exhibit No. 10 for identification and received in evidence.)

By Mr. Stowell:

Q. On the basis of your experience in introducing silica aerogel to insulation experts is it your opinion that they would have recognized the extraordinary utility of silica aerogel if Dr. Kistler had not pointed it out? A. I don't think so. The high cost of the material—although it is in a class by itself as an insulating material, it is in a class by itself on cost; and that seems to be as far as one's mind goes—that is, as far as the average person or expert's mind goes—in thinking of its use. As soon as the cost is brought out they seem to lose all interest in the material.

Q. By the way, what is the present market price of silica aerogel? A. It sells for 50 cents a pound.

Mr. Stowell. That is all.

Cross-examination

By Mr. Whitehead:

Q. As I understood you, you spoke of some difficulty in redesigning various structures to use this aerogel as an insulating material. Now, was there any difficulty in
39 redesigning an ordinary refrigerator such as shown
on this sketch, Plaintiff's Exhibit No. 7? A. Well, the design isn't difficult once one gets the idea. The part that impressed me about that is that when talking with experts—that is, men whose main occupation is design of refrigerator assemblies—the first question that those men ask perhaps might be, "What is the thermal insulating value of the material?" Well, you tell them and at once their interest becomes very acute. The second question is, "What is the price?" and then the interest falls off.

Now, in order to hold their interest you have to describe some such assembly like this, and actually the experts don't seem to readily grasp that design until it has really been pointed out to them and explained, and then it seems to dawn upon them.

Q. Well, can there be any difficulty if you told a man to redesign that refrigerator making the space between the two walls so much less than it was before? Would there be any difficulty in designing a refrigerator with walls spaced apart in a less number of inches than the walls in the original refrigerator? A. Well, a designer might conceivably attain thinner walls, but he may attain that by reducing the exterior dimensions.

Q. Well, that is apparent. If you tell him not to change the outside dimensions of the refrigerator, he certainly wouldn't change them. A. Well, as I answered before there, I think that once the idea has been given to a person, yes, the redesign of the unit is relatively simple, to an
40 expert.

Q. Well, wouldn't it be relatively simple to the ordinary man that designed that original refrigerator? A. Yes; I term him an expert.

Q. I understood you to say that you were familiar with Mr. Kistler's patent No. 2,093,454? A. Yes.

Q. That patent, does it not, describes as one of the characteristics of the aerogel material its thermal capacity, that is, its high insulating value? A. Yes.

Q. That is described in the patent, is it not? A. Yes, it is.

Q. And it also is stated as a characteristic of the product in certain claims of the patent, is it not? A. I believe so, yes.

Q. I have only this one copy. Will you look at the last line of claims 18, 19, and 22 and see if that statement isn't in each of those claims? A. The statement that the aerogel has a high thermal insulating power?

Q. Yes. A. Yes, it is.

Mr. Whitehead. That is all.

Mr. Stowell. That is all.

(The witness left the stand.)

Mr. Stowell. Call Dr. Samuel S. Kistler.

41 Thereupon **Samuel S. Kistler**, the plaintiff, was called as a witness for and on his own behalf and,

having been first duly sworn, was examined and testified as follows:

Direct Examination

By Mr. Stowell:

Q. Please state your name and address. A. My name is Samuel S. Kistler. My address is 148 Worcester Street, West Boylston, Massachusetts.

Q. What is your present position, Dr. Kistler? A. Associate director of research for the Norton Company.

Q. Will you state briefly your education and professional experience? A. I received an A. B. from Stanford University in chemistry in 1921. In 1922 I received the degree of chemical engineer from the same university. In 1929 I received the degree of doctor of philosophy from the same university. In the interim I spent one year in the engineering department of the Standard Oil of California and the remainder from 1923 to 1929 teaching at the College of the Pacific in Stockton, California. From 1929 to '30 I spent studying in Germany; '31 to '35 as assistant professor of chemical engineering at the University of Illinois. Since 1935 I have been with the Norton Company.

Q. Are you the Samuel S. Kistler who is the inventor of the apparatus and method for heat insulation described and claimed in the application in suit? A. Yes.

42 Q. You are also the inventor of the method and material of the United States patent 2,093,454? A. Yes.

Q. Will you please describe the conception of the invention of the application in suit, as far as you can remember? A. I was primarily interested in the structure of gels. I had spent considerable time both in this country and in Europe working on gels, and it occurred to me that one might learn something of their structure by removing the liquid without permitting collapse of the structure; and the process that has already been described by Mr. White was eventually arrived at.

In the fall of 1930 I made my first experiments, and they were successful in that I obtained the first samples of a silica hydrogel from which the water had been removed without collapse of the structure. The material was unique in its physical and optical properties. The optical properties showed that it must have a structure extraordinarily fine, that is, very fine compared to the wave length of light, so that some means other than customary measurements with the microscope would be required to determine the structure.

At that time I hit upon the idea that the mean free path of air molecules might be used as a measure of the distance of separation of these elements of structure and also of what might be termed the structural design. Since the mean free path of gas molecules is a linear function of the thermal conductivity, I turned to heat conductivity measurements in order to determine this quantity, and it was
43 during these measurements that I found that the heat
conductivity was so extraordinarily low.

Q. What were the results of this measurement as compared with the prior accepted ideal of still air? A. The ideal for still air, as was given by Professor Wilkes, is approximately the K factor of 0.17; whereas my figures run in the neighborhood of 0.16 for the earlier experiments.

Q. And lower values have been obtained since then? A. I have obtained values substantially lower than that. Other values by Professor Wilkes have been obtained as low, in my memory, as 0.12.

Q. How would you explain the possibility, Mr. Kistler, of a material holding enormous quantities of air, being substantially air from the weight point of view—from a volume point of view—having a conductivity less than that of still air? A. The conductivity of air is due to the movement of molecules through it. If all molecules could move in straight paths until they struck walls, struck the retaining vessel, the heat conductivity of air would be very high. However, the molecules have finite dimensions, and they strike each other; so that in moving an inch the molecules, on the average, will make approximately 250,000 impacts with each other. That slows up the progress of energy, that is, the movement of energy across the gas, to the point where air has a very low thermal conductivity. Now, if one can introduce, in the path of these molecules, obstacles such as the extraordinarily fine structure of the silica aerogel, and then substantially increase the number of 44 impacts that the molecules have to experience in traveling an inch, one can thus further decrease the heat conductivity of the air in the pore spaces.

For instance, in the customary silica aerogel instead of 250,000 impacts in an inch there are approximately 400,000 in an inch; the solid structure itself is so fine, so little of it, and so tortuous in its passage from one wall to the other, that most of the heat is conducted through the gas.

Q. Why did you consider the fact that silica aerogel has a lower conductivity than still air of so much importance, Mr. Kistler? A. May I ask you whether you mean theoretical?

Q. No. A. Or practical?

Q. From a practical point of view, from the point of view of the invention. A. It has very large practical importance because there is no other heat insulating material that will provide the same barrier to the passage of heat in the same thickness as the silica aerogel. It, in other words, can be used in thinner layer to offer the same thermal resistance as a much thicker layer of the customary insulating materials.

Q. I hand you a printed article entitled, "The Relation Between Heat Conductivity and Structure in Silica Aerogel," headed, "Reprinted from The Journal of Physical Chemistry. January, 1935." Is this your article? A. Yes.

Q. Briefly, what is the purpose of that article? A. This article was written as a theoretical discussion of the 45 structure of silica aerogel, making use of heat conductivity and the mean free path of gas as the means of measurement.

Mr. Stowell. The reprint is offered in evidence as Plaintiff's Exhibit 11.

(Reprint of article by Mr. Kistler was marked Plaintiff's Exhibit No. 11 for identification and received in evidence.)

Mr. Stowell. You may cross-examine.

Mr. Whitehead. No cross-examination.

By the Court:

Q. You speak of the interest in this that you have from the theoretical scientific point of view. A. Yes.

Q. Do you follow the theory or teaching that heat is caused or communicated by the vibration of molecules in matter? A. Yes.

Q. Then, you do not go down into the subdivision of the molecule, into the atoms or anything of that kind, for heat? A. No. The heat is—well, that must be modified a bit because the heat capacity of a molecule, that is, the amount of heat energy which it retains at any one temperature, is a function of the number of atoms, the size of the molecule, the way the atoms are held together; and consequently the heat conductivity of a gas is also a function of the configuration of the molecule, its content; but in a gas the heat is conducted from one wall to another by movement of molecules and not by separate atoms.

46 Q. So it is the vibration of the molecules that communicates the heat ? A. Yes, there is vibration if by "vibration" you mean the—

Q. (Interposing) Movement. A. Movement of molecules from one to another between impacts?

Q. Yes. A. Yes.

Q. Well, now, what did you find out or what is your theory of this aerogel in regard to the action of its molecules? A. The solid structure of the aerogel could be visualized as a felt. Perhaps you might think of it as a mat of glass wool, except submicroscopic in dimensions, and the gas molecules are moving in straight lines throughout this structure until they strike surfaces or until they strike each other.

Now, the actual volume of the silica in a cubic centimeter of the aerogel is only about 5 percent of the cubic centimeter, so that 95 percent is filled with gas. Then these gas molecules are rebounding from the solid surfaces of the silica or striking each other; and the heat motion, the heat movement through there, is a function of the distance the molecules go before they make an impact, and this extraordinarily fine structure reduces that distance that they can travel without impact, and therefore reduces the rates at which heat can be carried through the structure.

Q. So that, then, you say that this will not allow as much heat to pass through it is the former unit of air? A. That is right.

Q. Well, then, of course, it is somewhat far afield,
47 but how do you regard the heat coming from the sun
to the earth through space? What is the theory there
that conducts that heat through space, and there is no air
there? A. No.

Mr. Stowell. Maybe I can ask one question.

The Court. All right. It is just an interesting question.

The Witness. The heat is conveyed in two methods. I have described one; that is what is called conductivity. The other is by radiant energy, and the heat from the sun comes to us entirely by radiant energy since there is no conduction.

By the Court:

Q. I ask the question: There is nothing like that in this product in this case? A. Yes.

Q. Radiant energy? A. A small amount of radiant energy does get through, but it is so small compared to the—perhaps I should amend that. The amount of radiant energy that gets through is sufficiently small so that the over-all conductivity is still less than that through an equivalent amount of air.

Q. The radiant energy is negligible? A. Yes.

Q. In the substance here? A. Under normal circumstances. Now, it does become important under certain circumstances, and in that case the manufacturers put an opacifier in in order to block the radiant energy, keep it from passing through.

Q. Do you think that it may be possible in the future to
get some other substance or product that would have
48 a lower heat conductivity than this? A. Well, it
would be presumption of me to say that it is impossible.

Q. Yes. A. All I can say is that I don't know how it could be done.

The Court. Yes. That is all.

Mr. Stowell. If your Honor please, may I introduce on the record a certified copy of the file history as Plaintiff's Exhibit 12?

The Court. Very well.

(Certified copy of file history was marked Plaintiff's Exhibit No. 12 for identification and received in evidence.)

Mr. Stowell. That is all.

(The witness left the stand.)

Mr. Stowell. Does your Honor care to hear argument at the present time?

The Court. I will hear the defense.

Evidence on Behalf of the Defendant

Mr. Whitehead. I want to introduce in evidence on the part of the defendant a folder that I handed you, and I will hand you copies showing the items in it.

The Court. Very well. That will be received as Defendant's Exhibit 1.

Mr. Whitehead. Defendant's Exhibit 1.

The Court. Having items in it A, B, C, D, E, and F.

49 (Patent Office document was marked Defendant's
Exhibit 1 for identification and received in evidence.)

APPELLANT'S EXHIBIT NO. 3.

LANGE'S HANDBOOK OF CHEMISTRY, 2nd Edition, 1937
Pages 622-625

FILED
APR 22 1943
CHARLES E. STEWART

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PROPERTIES OF MATERIALS OF CONSTRUCTION
PHYSICAL AND THERMAL PROPERTIES OF HEAT INSULATING MATERIALS*

No.	Material	General composition	Commercial construction	Density, lb./ft.³	K, B.T.U.s/hr./ft.²/in./°F.	Mean Temp. of sample °F.	Temp. limit for service, °F.	Resistance per inch thickness 1/K	No.
1	Air	Still air	------------	0.08	0.167	32	-----	6.37	1
2	Aluminum foil crumbled	Crumbled foil and air—7 layers per 2.5 in.	Pipe covering	-----	0.680	500	-----	1.40	2
3	Asbestos fiber cements	Asbestos and clay	Cement	30.0	1.2	300	1,200	0.83	3
4	Asbestos fiber for underground conduit insulation	Willowed asbestos fiber waterproofed	Filling	8.8	0.545	300	375	1.83	4
5	Asbestos millboards	Asbestos pressed	Rigid sheets	60.5	0.842	86	1000	1.19	5
6	Asbestos paper	Indented, Has 25 laminations per in.	Pipe covering	16.1	0.666	500	700	1.50	6
7	Asbestos paper	With imbedded sponge particles 40 laminations per in.	Pipe covering and blocks	30.0	0.580	500	700	1.71	7
8	Asbestos paper products	Corrugated air cell type	Pipe covering and sheets	13.7	0.632	300	300	1.58	8
9	Asbestos paper, vitrified	Asbestos paper-treated with vitrifying solution and baked	Pipe covering and sheets	31.6	1.20	300	700	0.83	9
10	Bauxite, monohydrated	Molded with asbestos and clay	Pipe cov.-blocks and bricks	30.0	1.30	1,000	1,600	0.83	10
11	Cattle hair	Hair-felted	Blanket flexible	9.25	0.372	90	180	2.69	11
12	Cattle hair	Hair-felted	Blanket flexible	16.82	0.247	86	-----	4.05	12
13	Cattle hair and jute	Hair and jute felted	Blanket flexible	6.17	0.245	90	180	4.08	13
14	Cattle hair and other fiber	Confined with building paper	Blanket flexible	16.72	0.2762	86	-----	3.70	14
15	Corkboard	No artificial binder	Pressed rigid slabs	7.0	0.37	-----	-----	2.71	15
16	Diatomaceous earth and clay, calcined	Molded and fired	Bricks	42.3	2.25	1,000	2,000	0.44	16
17	Diatomaceous earth blocks	Molded with asbestos, magnesia and clay	Pipe covering and blocks	25.0	1.05	1,000	1,600	0.94	17
18	Diatomaceous earth bricks	Natural brick cut from earth, heat flow ⊥ to strata	Brick	27.7	0.92	1,000	1,600	1.09	18
19	Diatomaceous earth, calcined	Molded and fired	Bricks	35.0	2.12	1,000	2,000	0.47	19
20	Diatomaceous earth cements	Mixed with asbestos, magnesia and clay	Cement	20.0	0.725	400	1,600	1.38	20
21	Diatomaceous earth fillers	Coarse powder	Filler	20.0	0.98	1,000	1,600	1.02	21
22	Diatomaceous earth fillers	Fine powder	Filler	17.2	0.89	1,000	1,600	1.12	22
23	Fire felt	Long brown asbestos fiber and sodium silicate	Pipe covering and blocks	20.4	0.685	500	700	1.45	23
24	Fire felt	Short white asbestos fiber and sodium silicate	Pipe covering and sheets	30.6	1.30	500	1,600	0.77	24
25	Insulating boards	Pressed wood pulp	Rigid slabs	17.0	0.355	90	300	2.81	25
26	Insulating boards	Bagasse fiber	Rigid slabs	17.5	0.363	90	300	2.76	26
27	Insulating boards	Licorice roots	Rigid slabs	16.1	0.340	81	300	2.94	27
28	Insulating boards	Pressed wheat straw pulp	Rigid slabs	14.5	0.365	90	300	2.74	28
29	Kapok fiber	Tightly packed	Flexible	----	0.241	75	180	2.38	29
30	Magnesia	85% magnesia—15% asbestos	Pipe covering and blocks	14.5	0.543	400	600	1.83	30
31	Portland cement and calcined diatomaceous earth	Mixture of 4 pts. calcined earth to 1 pt. cement by volume	Poured as concrete	61.8	2.59	1,000	1,500	0.38	31
32	Rock cork	Rock wool and asphalt binder	Rigid slabs	16.6	0.355	86	180	2.83	32
33	Rock wool	Felted	Blankets	8.2	0.405	300	1,600	2.43	33
34	Rock wool	Felted with metal jacket	Pipe covering	16.4	0.582	400	1,600	1.82	34
35	Rock wool	Granulated	Filling	9.40	0.355	165	1,600	2.81	35
36	Rock wool	Loose	Filling	10.0	0.370	90	1,600	2.70	36
37	Rock wool	Molded with clay and asbestos	Sheets	16.2	0.384	300	1,600	2.60	37
38	Rock wool cement	Rock wool and clay	Cement	20.0	1.02	500	1,200	0.98	38
39	Sheetrock	Gypsum and sawdust	Rigid sheet between heavy papers	65.3	1.40	90	-----	0.385	39

*See also the tables: Heat Conductivity of Commercial Insulators.

PROPERTIES OF MATERIALS OF CONSTRUCTION
PHYSICAL AND THERMAL PROPERTIES OF HEAT-INSULATING MATERIALS

No.	Material	General composition	Commercial construction	Density, lb./ft.³	K, B.T.U.s/hr./ft.²/in./°F.	Mean Temp. of sample °F.	Temp. limit for service, °F.	Resistance per inch thickness 1/K	No.
1	Spun glass	Fine glass fibers, ⊥ to heat flow	Blanket	5.25	0.690	400	1,000	1.45	1
2	Thermax	Shredded wood and cement	Rigid sheet	24.2	0.46	72	200	2.07	2
3	Wool paper and hair	Laminated	Pipe covering	15.6	0.308	80	180	3.25	3
4	Wool paper products	Laminated wool felt	Solid pipe covering	24.5	0.402	120	200	2.31	4
5	Wool paper products	Indented wool felt	Pipe covering	15.0	0.337	120	200	2.97	5
6	Wool paper products	Wool paper and asphalt saturated paper—alternated	Pipe covering	21.7	0.460	112	200	2.17	6

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APPELLANT'S EXHIBIT NO. 4.

MARK'S MECHANICAL ENGINEERS' HANDBOOK, 4th Edition, 1941
Pages 394 & 395

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defined as the quantity of heat (Btu) that flows in a unit of time (1 hr) through unit area of plate (1 sq ft) of unit thickness (1 ft) having unit difference of temperature (1 deg F) between its faces. The mean thermal conductivity k_m is given the relation, for steady flow of q Btu per hr through a wall having mean surface area A_m sq ft and a thickness of L ft:

$$q = k_m A_m (t'_i - t'_o)/L, \quad \text{or} \quad k_m = qL/A_m(t'_i - t'_o) \qquad (3)$$

It will be observed that the units of the conductivity k contain the element of thickness, while the coefficient h does not. The thermal conductivity of a given material varies with temperature and

$$k_m(t'_i - t'_o) = -\int_{t'_i}^{t'_o} k\,dt$$

Over moderate ranges, k varies linearly with t', and hence k_m may be evaluated at the arithmetic mean of t'_i and t'_o. The numerical value of the mean area A_m, in $qL/A_m = q\int dL/A$, depends on the shape of the conductor. For flat plates, $A_m = A_i = A_o$; for the hollow cylinder,

$$A_m = (A_i - A_o) \log_e (A_i/A_o) \qquad (4)$$

and for the hollow sphere, $A_m = \sqrt{A_i A_o}$. For more complex shapes, a shape factor may be evaluated by a graphical procedure (Awbery and Schofield, *Proc. 5th Intern. Congr. Refrig.*, 3, 1929, pp. 591–610).

The thermal conductivity of different materials varies greatly. For metals and alloys k is high, while for certain insulating materials, as asbestos, cork, and kapok, k is very low. In general, k varies with the temperature. In the case of metals, k usually decreases with rising temperature, while for most other substances the reverse is true. Tables 1 to 7, collected from various sources, give values of thermal conductivity. For refractories, see p. 764; for pipe coverings, p. 1108; for building materials, p. 1639. Conversion factors for various units are given on p. 81.

Table 4. Thermal Conductivities of Material for Refrigeration and Building Insulation

Material	Apparent density, lb per cu ft	Mean temp	k	Material	Apparent density, lb per cu ft	Mean temp	k
Balsa wool	2.2	[illegible]	[illegible]	Insulex or pyrocell	8.0	[illegible]	[illegible]
Cabots quilt	3.4	[illegible]	[illegible]	Insulex or pyrocell	12.0	[illegible]	[illegible]
Cork board	10.0	[illegible]	[illegible]	Insulex or pyrocell	18.0	[illegible]	[illegible]
Cork, granulated	7.3	[illegible]	[illegible]	Insulex or pyrocell	24.0	[illegible]	[illegible]
Cork, regranulated, (baked)	8.1	[illegible]	[illegible]	Insulex or pyrocell	30.0	[illegible]	[illegible]
Dry zero (Kapok)	1.0	[illegible]	[illegible]	Lincofelt	11.3	[illegible]	[illegible]
Flaxlinum and fiberfelt	11.3	[illegible]	[illegible]	Lith	14.3	[illegible]	[illegible]
Gypsum, molded and dried	70.0	[illegible]	0.25	Rock cork	16.0	[illegible]	[illegible]
Hair felt	11.0	[illegible]	[illegible]	Rock wool	14.0	[illegible]	[illegible]
Hairinsul	6.3	[illegible]	[illegible]	Sil-O-Cel	10.6	[illegible]	[illegible]
Insulating boards, Insulite, Celotex, etc.	14.8	[illegible]	[illegible]	Thermofill	34.0	[illegible]	[illegible]
				Vermiculite (expanded)	6.3	[illegible]	[illegible]
				Wool felt	20.6	[illegible]	[illegible]

Table 5. Thermal Conductivities of Insulating Materials at High Temperatures

Material	For temperatures, deg F up to	Mean temperature, deg F									
		100	200	300	400	500	600	800	1000	1500	2000
Laminated asbestos felt (approx 40 laminations per in.)	700	0.033	0.037	0.040	0.044	0.048					
Laminated asbestos felt (approx 20 laminations per in.)	500	0.045	0.050	0.055	0.060	0.065					
Corrugated asbestos (4 plies per in.)	300	0.050	0.058	0.069							
85 percent magnesia	600	0.039	0.041	0.043	0.046						
Diatomaceous silica, asbestos and bonding material	1600	0.045	0.047	0.049	0.050	0.053	0.055	0.060	0.065		
Diatomaceous silica brick	1600	0.054	0.056	0.058	0.060	0.063	0.065	0.069	0.073		
Diatomaceous silica brick	2000	0.127	0.130	0.133	0.137	0.140	0.143	0.150	0.158	0.176	
Diatomaceous silica brick	2500	0.128	0.131	0.135	0.139	0.143	0.148	0.155	0.163	0.183	0.205
Diatomaceous silica powder (density, 18 lb per cu ft)	....	0.039	0.042	0.044	0.048	0.051	0.054	0.061	0.068		
Rock wool	....	0.030	0.034	0.039	0.044	0.050	0.057				

Asbestos cement, 1.2; 85 percent magnesia cement, 0.6; asbestos and rock-wool cement, 0.9 approx.

The conductivity of air as a function of temperature is given by the relation,

$$k_T = 0.0129[717/(T + 225)](T/492)^{3/2}$$

where T is temperature in deg F absolute. This relation is valid from −312 to 212 F. Values of the conductivities of air and steam at a series of temperatures are given below, those at 300 F being extrapolated.

For t (deg F)	32	50	100	200	300
k (for air)	0.0139	0.0133	0.0148	0.0168	0.0180
k (for steam)	0.0086	0.0090	0.0101	0.0122	0.0144

Table 6. Thermal Conductivities of Insulating Materials at Moderate Temperatures (Nusselt)

Material	Weight, lb per cu ft	Temperatures, deg F						
		32	100	200	300	400	600	800
Asbestos	36.0	0.087	0.097	0.110	0.117	0.121	0.125	0.130
Burnt infusorial earth for pipe coverings	12.5	0.043	0.046	0.052	0.057	0.062	0.073	0.085
Insulating composition (loose)	25.0	0.040	0.044	0.050	0.053	0.055		
Cotton	5.0	0.032	0.035	0.039				
Silk hair	9.1	0.026	0.030	0.034				
Silk	6.3	0.025	0.028	0.034				
Wool	8.5	0.022	0.027	0.033				
Pulverized cork	10.0	0.021	0.026	0.032				
Infusorial earth (loose)	22.0	0.035	0.039	0.043	0.047	0.050	0.053	

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APPELLANT'S EXHIBIT NO. 5.

metallic surfaces are much poorer radiators than nonmetallic surfaces, such as brick, stone, glass, wood, plaster, paper, etc.

The terms conductance and resistance (insulating value), as already defined, can be applied to an air space as well as to a slab of solid material. On account of the large effects of radiation and convection, however, the insulating value of an air space is not proportional to its width (thickness), as would be the case with a slab of uniform solid material. Furthermore, the insulating value varies considerably with both mean temperature and temperature difference. For spaces more than about three-fourths inch wide the insulating value is practically constant, independent of the width. Narrower spaces have less insulating value, and below about one-half inch the insulating value is approximately proportional to the width. Under average conditions the conductance of the vertical air spaces commonly found in building walls is about 1 B. t. u. per hour, per square foot, and per temperature difference of 1° F. It will be seen later that this figure corresponds to an insulating value approximately equivalent to a one-third inch thickness of average insulating material.

IV. INSULATING MATERIALS

A thermal insulator is essentially a material having a large percentage of relatively small voids containing air. Little, if any, convection can take place within such a material, and the solid portions effectively screen off the radiation, so that the low conductivity of air is utilized to a much greater extent than in an air space. Since every known solid material has a greater thermal conductivity than air, it is evident that the conductivity of air fixes the lower limit of the conductivity of insulating materials containing air. By exhausting the air from an insulating material the conductivity can be materially reduced, and although this principle is made use of in certain types of thermos bottles and jars, it is impracticable on a large scale.

The application of the term thermal conductivity has thus far been restricted to uniform or homogeneous materials. Insulating materials are obviously not homogeneous in the microscopic sense, but in a practical sense they may be considered homogeneous, since their structure is fine-grained in comparison with the size of the specimens ordinarily dealt with. Bearing this in mind, we may use the terms thermal conductivity and insulating value in the same sense as they have been used in the case of homogeneous materials.

Investigation has shown that the differences in the respective thermal conductivities of the various light fibrous or cellular materials are not very great. The conductivities of most materials manufactured and sold primarily as insulators fall within the range 0.25 to 0.35 B. t. u. per hour, square foot, and temperature gradient of building materials, and like building paper, may be valuable in reducing infiltration of air through an otherwise porous wall.

Figure 1 is a chart showing in a general way the respective insulating values of a number of classes of poor heat-conducting materials. Insulating values, as previously defined, are plotted against the weight per unit volume of the material. The upper limit shown is the insulating value of a layer of still air 1 inch in thickness, and all other values are calculated on the basis of the same thickness. As discussed above the high insulating value of air alone can not be completely utilized in practice, but it represents the ideal case. It must not be supposed that the insulating values of all materials fall exactly on one or another of the lines shown in Figure 1. These lines are only approximate, but they give a general picture which is accurate enough for most purposes. One class of materials used to some extent for insulation—namely, loose powdered or granular materials, such as granulated cork, sawdust, charcoal, etc.—can not be represented by a single line in Figure 1. The insulating values of materials of this class fall within the area inclosed by the dotted lines shown in the figure.

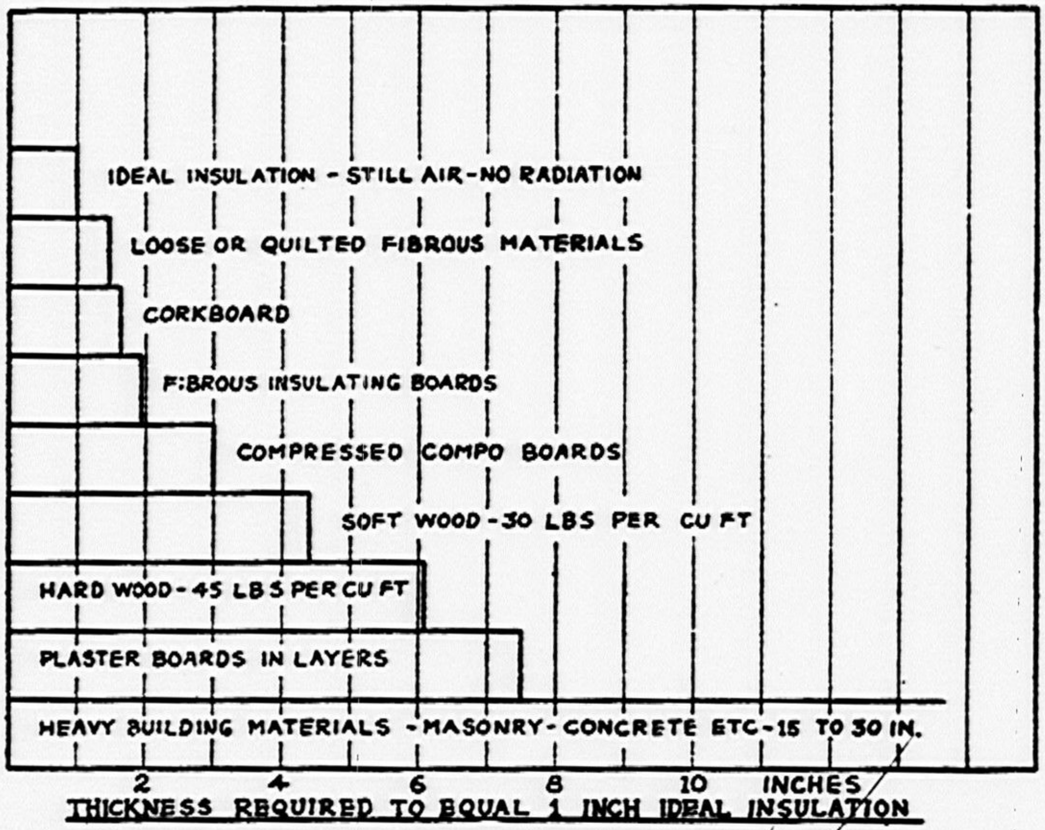

Figure 2.—*Thicknesses of various materials having equivalent heat-insulating values*

In Figure 2 the data are presented from a somewhat different point of view where commercial materials have been divided into more restricted groups, taking into account average densities within each group. The horizontal scale gives approximately the thickness

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Kistler vs. Cox
13971-C.A.

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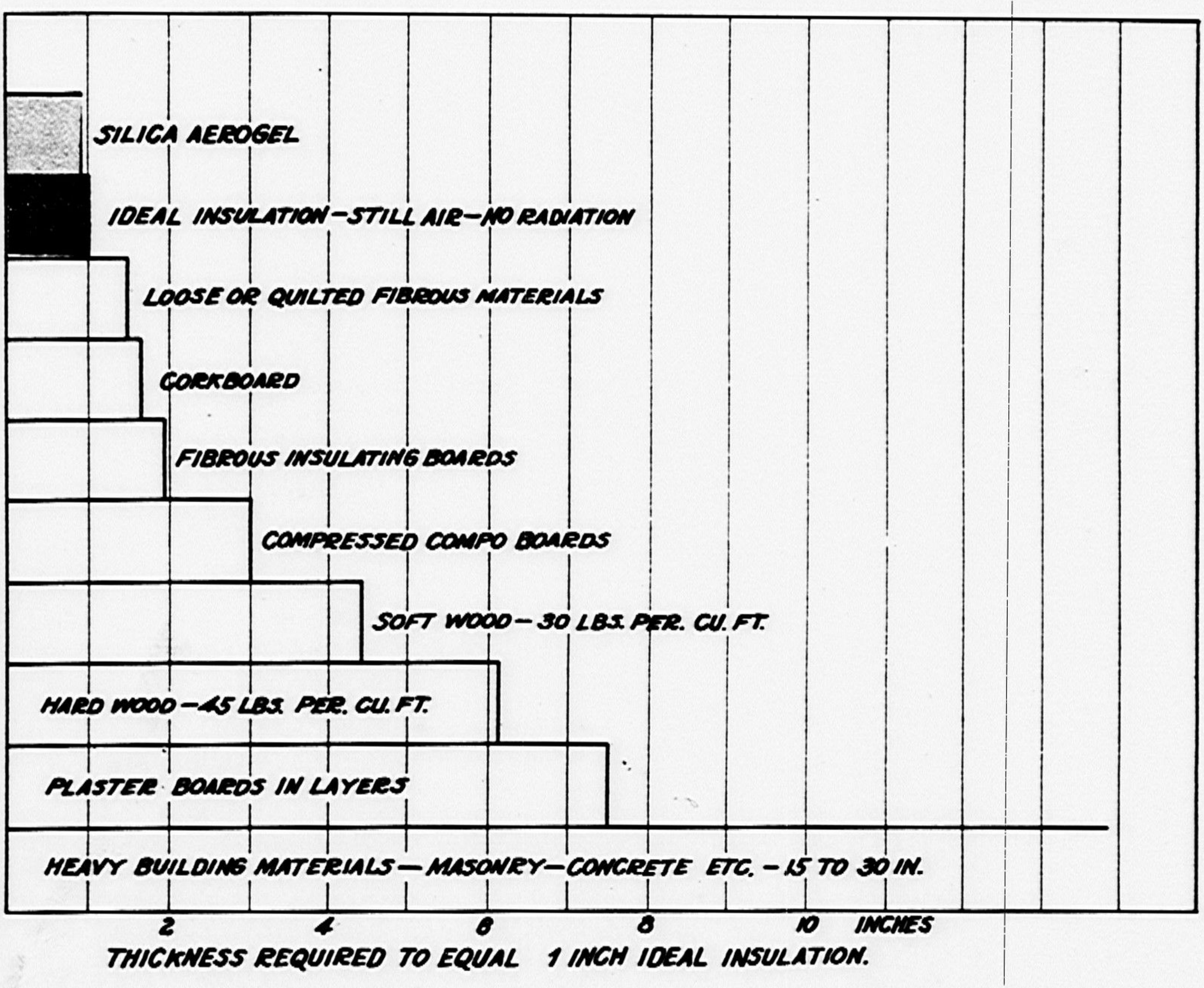

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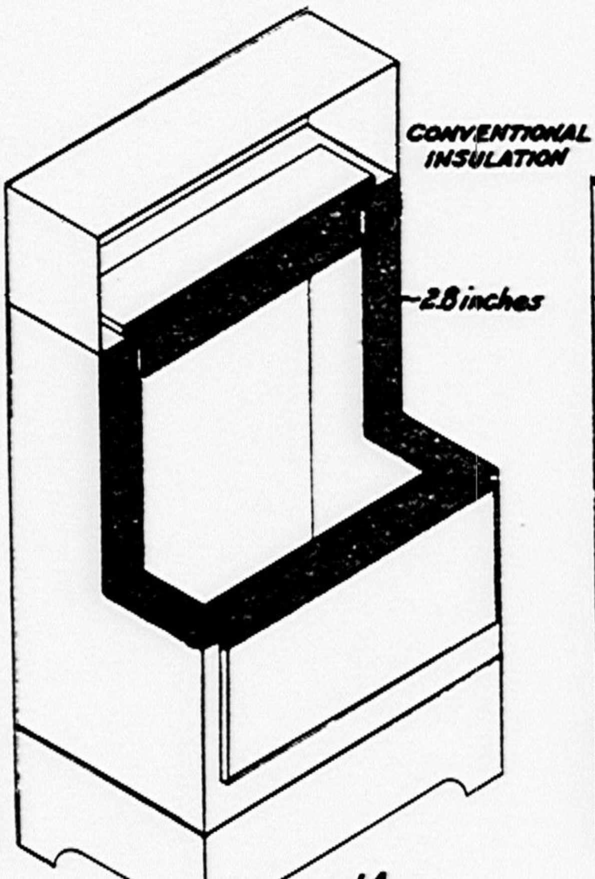
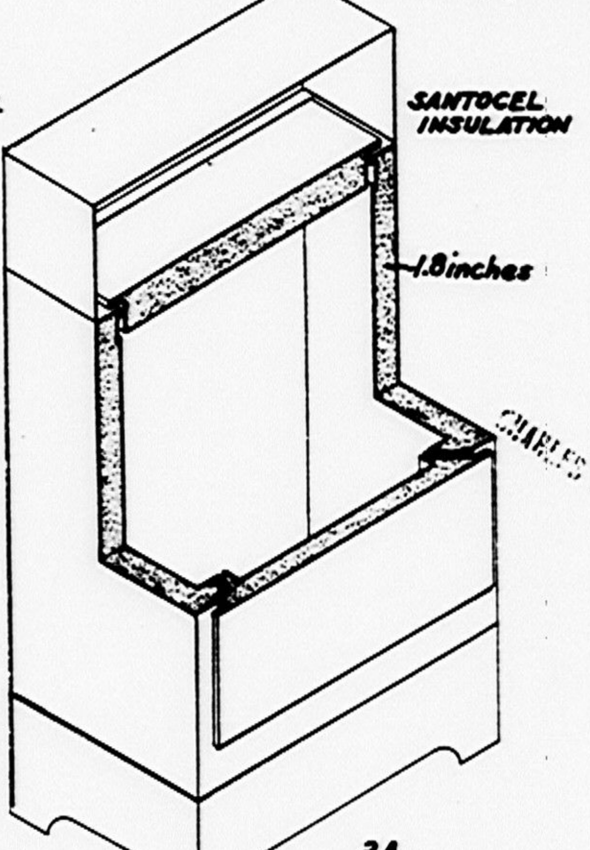
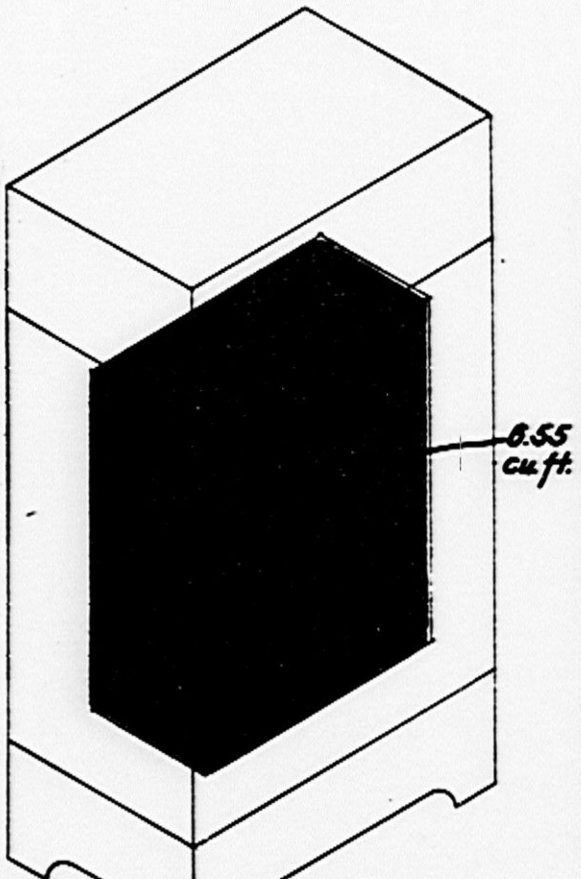


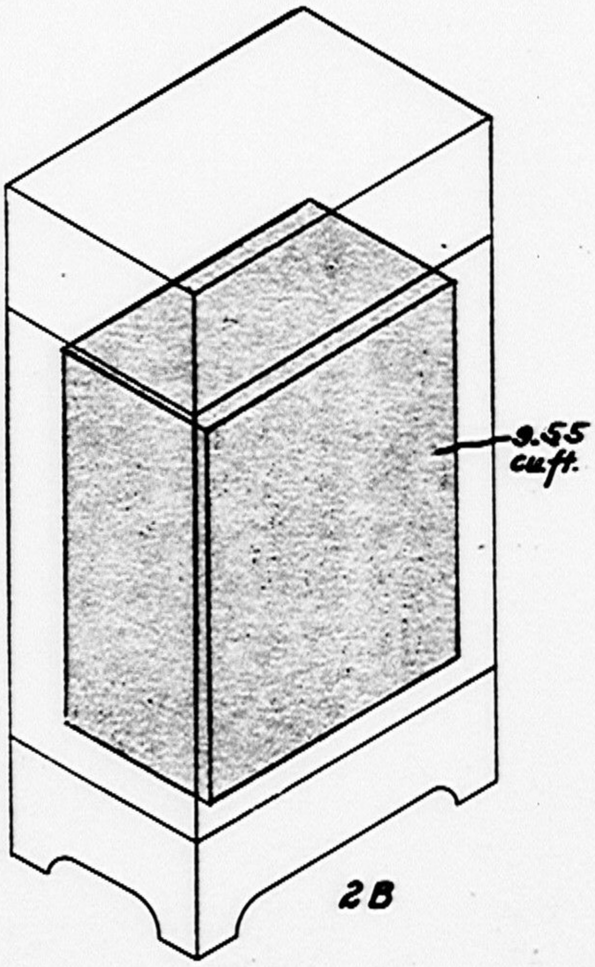
1A



2A



1B



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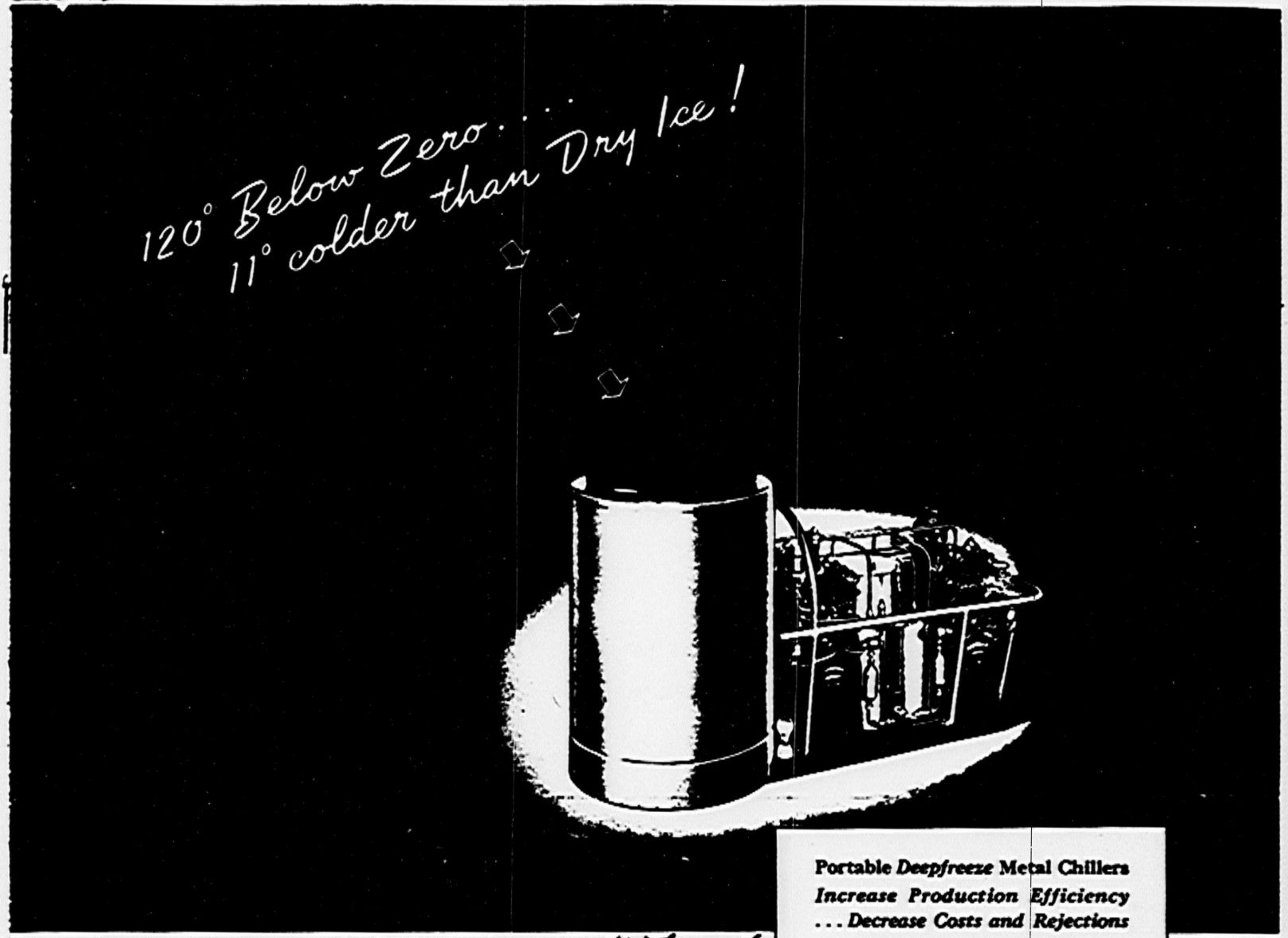

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Krotler vs. Cox
13971-C.C.

Deepfreeze

"Santocel" INDUSTRIAL UNITS SHRINK METALS MORE EFFICIENTLY..AT LOWER COST

COLD—so constant in its unvarying intensity that it becomes a usable tool in the hands of scientist, engineer, and practical production man—is produced in economical and convenient form by the new Deepfreeze Santocel Industrial Units. • Economical, because it is generated in spacious capacity by the Deepfreeze barrel-like container, at a current cost of only a few cents per full 24-hour day. • Convenient, because the Deepfreeze Santocel cold cylinder is portable . . . can be taken *to the job* to save man hours, and prevent production slow-downs. Deepfreeze Santocel Industrial Units give results in metal shrinking that show minimum variation. Constant and controllable temperatures are made possible by the solid wall of primary freezing surface; the top opening which prevents "spill-out" of cold; and the extraordinary thermal efficiency of Santocel (new, improved insulation composed of processed Silica vastly expanded by the auto-clave method). If your needs are dictated by war production requirements, we will make every effort to fill your order with units designed to fit your particular problems.

Deepfreeze "Santocel" cycles from −40° to −80°.
Deepfreeze Cascade "Santocel" cycles −120° and lower.

Portable *Deepfreeze* Metal Chillers *Increase Production Efficiency . . . Decrease Costs and Rejections*

For contraction in compound fitting of metal parts. This practice facilitates slide fits in assembly operations; relieves strain and possible fractures.

For storage of annealed aluminum alloys. Many aircraft manufacturers have adopted Deepfreeze "Santocel" units to maintain soft rivets.

For seasoning, setting, and counter annealing. Tool and gauge shops use Deepfreeze chilling to eliminate the warp, run-out, and other obstacles to precision craftsmanship.

For testing aircraft instruments and for many other uses where dry ice replenishment is necessary.

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MOTOR PRODUCTS CORPORATION
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APPELLANT'S EXHIBIT NO. 9.

Reprinted from The Journal of Commerce Tuesday, Sept. 8, 1942

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Deepfreeze

"COLDER THAN DRY ICE" TEMPERATURES SPEED AMERICA'S WAR PRODUCTION

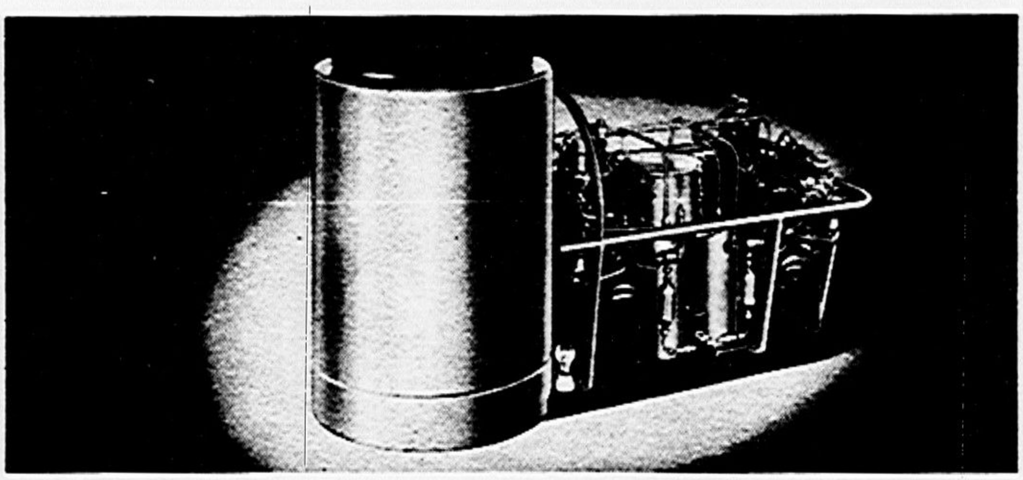
Portable Industrial Chillers Perform New Miracles for Science and Metallurgy

Metals subjected to the magic of DEEPFREEZE "colder than dry ice" temperatures, shrink sufficiently to permit the human hand to perform a press fit operation normally requiring a powerful hydraulic press.

Tool steel, high-temperature-quenched and cooled to 100° below zero, yields a combination of hardness, strength and ductility previously unknown to the metallurgical industry.

These and dozens of other applications of temperatures from 40° to 120° below zero, provided by DEEPFREEZE INDUSTRIAL CHILLING EQUIPMENT, are speeding America's all-out war efforts in scores of industrial plants, to a degree never before thought possible.

The DEEPFREEZE SANTOCEL CASCADE chilling unit is proving the most widely discussed development of modern refrigeration. Today it is performing yeoman service for the aviation industry, for the rubber industry, in the tool-steel field, in testing laboratories, in chemicals, pharmaceuticals and others too numerous to mention.



120° Below Zero—11° Colder Than Dry Ice. No Refilling... No Recharging...No Defrosting...Pays for Itself

If you want to increase production efficiency, decrease costs and rejections, you will want to investigate DEEPFREEZE METAL CHILLING EQUIPMENT.

DEEPFREEZE provides an established procedure in shrink fit assembly operations where infinite precision is required and where dry ice is now employed.

DEEPFREEZE is also especially adapted to seasoning, setting and counter-annealing where temperatures down to 120 degrees below zero Fahrenheit are required.

A complete brochure of technical information is available to interested executives, including a copy of Gordon and Cohen's research into "The Transformation of Retained Austenite in High Speed Steel at Subatmospheric Temperatures," originally published by the American Society For Metals.

Send for it on your letterhead.

Deepfreeze Division

MOTOR PRODUCTS. CORPORATION

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APPELLANT'S EXHIBIT NO. 10.

Kistler vs. [illegible]
13971-C.A.

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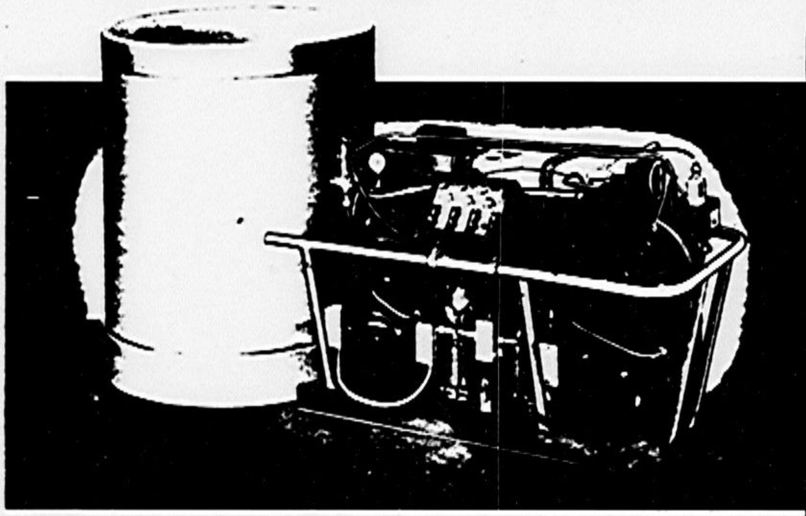
APR 22 1943
CHARLES E. STEWART, Clerk

How *Deepfreeze* Speeds the Shrinking, Testing *and* *Treating* of Metals . . . .



Removes 1000 B.T.U.'s per hour at –120° F.

In addition to eliminating the inconvenience of handling dry ice, the Deepfreeze *Cascade* Chilling Unit produces and maintains a temperature substantially 29° colder than dry ice.

Laboratory tests on high-speed steel reveal that this additional chilling capacity will produce "combinations of hardness, strength and ductility unobtainable by ordinary hardening and tempering. Temperatures colder than minus 150° Fahr. have no useful effect on high-speed steel, and may produce cracking in the metal. Temperatures *warmer* than minus 100° Fahr. are relatively ineffective." Therefore, temperatures ranging between minus 100° Fahr. and minus 150° Fahr. are ideal for the proper treatment of high-speed steel.

THE DEEPFREEZE CASCADE INDUSTRIAL CHILLING UNIT has a chill-chamber 24" in diameter x 30" deep. It is equipped with two motors and two compressors of the open silent-valve head, water-cooled, piston type. It has a heat absorbing capacity equivalent to 196 lbs. of dry ice per 24-hour day under similar operating conditions.

The same standard unit can be furnished 60" deep, or deeper.

Special Units can be furnished to suit specific applications.

EFFECTS SAVINGS UP TO [illegible] PER YEAR OVER DRY ICE—Laboratory tests prove that the cost for removing 1000 B.t.u.'s per 24-hour day over a period of one year with dry ice is $3000.00, as compared to the $175.00 electric current consumption of the Deepfreeze over the same period of time.

FREE DATA *and proof of the outstanding success of the Deepfreeze method for chilling metals are included in this booklet. Write for your copy today.*

SOME PRESENT PRODUCTION USES OF DEEPFREEZE METAL CHILLING

- The Deepfreeze Santocel Cascade Industrial Unit is ideal for production chilling of various metals in many industries. These descriptions may suggest a profitable application to your product . . . Deepfreeze engineers will be glad to study the possibility of saving time and money through the proper application of cold to your production.

- Shrinking of metal at –100° F. to –120° F. has made it possible to assemble sleeve bearings and ball or roller races otherwise requiring a press-fit, by merely slipping them into position after chilling.

- Spoilage of expensive bearings and races and loss of time for replacement are *entirely eliminated.*
- Storing and chilling annealed aluminum alloy rivets retard age hardening. Rivets can be kept soft enough for heading for a period of two weeks.

- For seasoning, setting and counter annealing, tool and gauge shops use Deepfreeze Chilling to eliminate the wear, runout and other obstacles to precision craftsmanship.
- Testing of metals at sub-zero temperatures has made it possible to study the reactions of aircraft instruments to stratosphere flying. Aircraft engine lubricants can also be perfected for sub-zero starting.

FREE ENGINEERING ASSISTANCE

- Deepfreeze engineers are available to assist you in obtaining the advantages of sub-zero metal conditioning. Send us an outline of your problems together with parts or prints for a preliminary calculation and test—no obligation.

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Metal Progress, November, 1942
Product Engineering, November, 1942
American Machinist, November 12, 1942
Iron Age, November 5, 1942
Machine Design, November, 1942

75 **APPELLANT'S EXHIBIT NO. 11.**

Endorsed: Filed Apr. 22, 1943. Charles E. Stewart, Clerk

Reprinted from
The Journal of Physical Chemistry
Vol. 39, No. 1, January, 1935

The Relation Between Heat Conductivity and Structure in Silica Aerogel

S. S. Kistler
Department of Chemistry, University of Illinois,
Urbana, Illinois

Received June 14, 1934

The structural units of jellies have dimensions of such an order that they have failed to yield to the ordinary methods of mensuration. Electrical conductivity, diffusion, and adsorption measurements have yielded figures of questionable accuracy on account of the uncertainties involved in the interpretation of the results. Ultramicroscopic studies in optically empty jellies are fruitless, while a measurement of the Rayleigh scattering of light, when it is intense enough to be measured, can at best give only qualitative results because the elements of structure are far too close together to obey Rayleigh's equations. The situation is somewhat better with gelatinous membranes where ultrafiltration of colloidal particles and Bechold's bubble test are available, but in the former case one is far from certain that the maximum diameter of particle that passes the membrane is within a factor of 10 of the actual average diameter of channel through which it passes, and a corresponding uncertainty enshrouds the bubble test, owing to the fact that only the largest passages can be thus estimated and also owing to uncertainty of the surface tension at small radii of curvature. X-ray methods can indicate only the size of crystal in crystalline gels, but can in no way indicate the relation between the size of crystal and size of structural units, e.g., fibrils, platelets, spheres, etc., from which the gel is constructed.

The development of a process for the replacement of the liquid in a jelly by a gas with little or no change in its structure (2) has made available a powerful new measuring rod, the mean free path of the gas molecules. The kinetic theory of gases has received such substantiation and acceptance in the past two-thirds of a century that the mean free path may be regarded as one of the well-established physical quantities.

Two methods of associating dimensions within the aerogel with the mean free path of a gas have been used in this laboratory. By forcing a gas through an aerogel at different absolute pressures, the pressure at which the type of flow through the gel changes from viscous to molecular can be found and related to the average size of opening through which the gas passes. The results of this work will
76 be published later. The second method relies upon
the linear relation between heat conductivity of a gas and its mean free path, other quantities being held constant.

Relation between Mean Free Path and Heat Conductivity of a Gas

According to the kinetic theory of gases, thermal conductivity of a gas is associated with the mean free path by the equations

$$k = Bc_v\eta \tag{1}$$

and

$$\eta = 0.35\ \rho v l \tag{2}$$

where k is the coefficient of heat conductivity, B is a constant, c_v is the specific heat of the gas at constant volume, η is the viscosity, ρ the density, v the arithmetical average velocity of the molecules, and l the mean free path. The constant 0.35 is due to Boltzmann. The coefficient k can then be represented by the expression

$$k = k'l \tag{3}$$

where k' is a function of the pressure, temperature, and composition of the gas.

Since we know nothing of the nature of the fine structure in an aerogel except that the free spaces are much larger than the elements of structure themselves (aerogels with 98 per cent void space have been produced), we will think of a large number, N, of molecules randomly distributed through the aerogel, starting from rest and moving in straight lines in all directions until they collide with structural elements of the gel. If the structure is random, which we must assume, the fraction $\frac{dn}{N-n}$ of the molecules that have not yet struck surfaces will impinge within the distance dx, where n is the number that have already struck. Therefore

$$dn = \frac{N-n}{L}\,dx \tag{4}$$

where $\frac{1}{L}$ is the proportionality factor. Integration gives

$$n = N\left(1 - e^{-\frac{x}{L}}\right)$$

which is the familiar equation connecting the number of impacts between molecules with distance in a gas, and L can now be defined as the mean free path of a highly attenuated gas within the aerogel. In other words, $\frac{e-1}{e}$ or 63 per cent of the molecules will hit surfaces in the distance L.

• • • • • • • • • •

85 *Specification*

To All Whom It May Concern:

Be it known, that I, Samuel S. Kistler, a citizen of the United States of America, residing at West Boylston, have invented certain new and useful improvements in
86 THERMALLY INSULATED STRUCTURES AND METHOD OF MAKING SAME of which I declare the following to be a full and clear description:

The present invention relates to thermally insulated structures of various types and kinds and for various uses, as well as to the method of insulating such structures. The structures provided by the present invention have the ability to transfer heat at a very slow rate as compared to known insulated structures and without the necessity of providing a low vacuum and means for maintaining such low vacuum.

Many thermal insulating materials are in use but none have proven satisfactory for more than a few purposes. Many previously known thermal insulators are often difficult to handle requiring pre-shaping to fit the structure to which they are to be applied, and must be used in large quantities or bulky masses to attain a desired result; and often are unsuitable for the purposes for which they are used.

It has been found that if a relatively small quantity of a material known as aerogel described in co-pending patent application Serial No. 746,412 filed October 1, 1934, be placed in close proximity to the walls of the structure, which is to be thermally insulated, the same insulating effect is obtained as if a much larger quantity of other thermal insulating materials, previously known, were used and the weight of the insulator will be much less than if the same volume of any other insulator had been employed. Accordingly, much better insulation is obtained by the use of the same volume of aerogel and yet its weight is much less than if anothr insulator had been used. This method is applicable to a wide variety of structures and is especially valuable when the structure is frequently subjected to alternate heating and cooling operations.

87 An object of the invention is to provide a more effective thermally insulated structure where it is desirable or necessary to employ a solid insulating material for this purpose; for example, the volume and weight of the solid insulator needed according to the present invention being greatly reduced over those previously known because of its lightness in weight and lower thermal conductivity, results in a larger thermally insulated space for any given overall dimensions.

Another object of the invention is the provision of means whereby a preformed structure may be insulated with great facility.

Another object of the invention is the provision of an insulated structure that is more easily and conveniently made.

With the above and other objects in view, as will appear from the following description, the invention resides in the combination of elements herein described and particularly as pointed out in the appended claims.

Figure 1 is a longitudinal sectional view of an ice cream storage refrigerator of the type usually used in retail stores constructed in accordance with the present invention;

Figure 2 is a top view of Figure 1 constructed in accordance with the present invention;

Figure 3 is a vertical sectional view of a thermally insulated bottle constructed in accordance with the present invention;

Figure 4 is a vertical sectional view of a refrigerator commonly used for domestic purposes constructed in accordance with the present invention;

88 Figure 5 is a vertical sectional view of a tank car constructed in accordance with the present invention, and

Figure 6 is a vertical sectional view, somewhat diagrammatic, of a steam locomotive constructed in accordance with the present invention.

Referring to the drawings in detail wherein like characters of reference refer to like and similar parts throughout the several views, 10 denotes the outer wall or shell of a typical ice cream storage container (see Figures 1 and 2) which may be of any desired shape or dimension and constructed of any suitable material, however, metal being preferred. The outer shell 10 is further provided with a bottom wall 11 and with a tightly fitting removable top wall 12 having a suitable opening 13 therein, preferably located in the central portion of the top 12. Within the outer container 10 is disposed an inner container 14 of similar shape to that of the outer container and otherwise of the same construction except that the top wall thereof 15 is preferably integral with the side walls.

The inner container is elevated from the bottom 11 of the outer container and rests upon suitable spacing members 16, which may be wooden blocks or strips interposed between the bottoms of both containers. The opening 13^a of of the inner container is of substantially the same dimensions as the opening 13 of the outer container and is aligned therewith.

89 It is, of course, understood that the walls of the inner and outer container are to be spaced apart and out of contact with each other in order to receive the insulating material 17, which is in granular or powdered form, preferably the latter, so as to eliminate large air spaces between the particles. The space between the inner and outer containers may be such as is desirable or found necessary in each particular instance, although in view of the low thermal conductivity of aerogel this space will be relatively less than that necessary when other known solid insulating materials are used. The powdered aerogel 17 is poured into the space between the inner and outer containers through the top of the outer container before the latter is closed, and completely occupies the space. This may be accomplished by first placing a suitable amount of the aerogel on the bottom of the outer container to a depth substan-

tially the height of the spacing members 16 and suitably packing the same; then placing the inner container in position and subsequently filling the rest of the space between the two containers with the aerogel. A cylindrical wall or collar 18 extends between the openings in the inner container 14 and the outer container 10 there being, preferably, an upstanding annular flange 19 about the peripheral edge of the opening 13ª against which the lower end of the collar 18 may bear.

A cover 20, preferably made of wood, is disposed at the top of the outer container 10 and has an opening therein of substantially the same shape and dimensions as the opening 13 and 13ª and is aligned therewith. This cover is for sealing the powdered aerogel into the space of the inner and outer containers and is sealed to the outer container at *a* and to the cylindrical collar at *b* by any suitable material, such as asphalt cement, and the collar 18 is similarly sealed to the ring 19 at *c*. The cover 20 preferably lies flush with the upper edge of the outer container 10 and over which the top 12 lies, the top 12 being provided with downwardly extending flanges 12ª which will overlap the edges of the outer container and the upper edges of the collar 18.

At a suitable distance above the bottom wall 14ª of the inner container is disposed a shelf 21 which may consist of a plurality of slats or a sheet of material preferably perforated or slotted and which rests upon brackets or other support 22 within the inner container. Below the shelf may be disposed a cooling medium, such as dry ice, or the like, and the material to be kept cool may be inserted through the openings 13 and 13ª and disposed upon the shelf 21. The material to be kept cool may be in any form such as packages of ice cream or other materials or may be in another container 23, such as the cylindrical ice cream cans; but at any rate a sufficient space should be kept between the material to be kept cool and the side walls of the container 14 to permit convection and currents to set up thus keeping the material uniformly cooled throughout the container 14. Of course, it will be understood that a suitable removable cover 24 is to be provided to close the opening 13 and may be also constructed by the provision of spaced walls between which aerogel will be disposed.

91 With reference to Figure 3 which shows a thermally insulated bottle constructed in accordance with the present invention the device comprises an outer jacket 25 surrounding a bottle 26 closed by a suitable cork or other means 27, the jacket being closed by a cap 28 overlying the stopper 27. The jacket 25 preferably consists of two spaced inner and outer walls of similar configuration to that of the bottle 26. Between the inner and outer walls *i* and *o* of the jacket 25 is disposed powdered aerogel insulator which may be introduced between these walls in any suitable manner preferably through openings provided at the top edges of these walls, as at 29, and then the openings sealed in a suitable manner. It is within the purview of the invention to evacuate the space between the walls *i* and *o* after introducing the powdered aerogel and before sealing the openings at 29. By the introduction of powdered aerogel between the walls *i* and *o* in the manner just described, the powdered aerogel in addition to adding to the thermal efficiency serves to add to the structural strength of the jacket to prevent collapse which may be produced by the vacuum, thus allowing relatively thin walls to be employed in the construction of the jacket.

With reference to Figure 4 which discloses a domestic refrigerator a, the inner and outer walls *i* and *o* of said jacket is filled in a suitable manner with aerogel.

Similarly Figures 5 and 6 show respectively a tank car and a locomotive, each comprising spaced inner and outer walls *i* and *o* having the space therebetween filled with aerogel and about the parts thereof which it is desired to insulate either to prevent the entrance of heat from the
92 outside to the interior thereof or to prevent the escape of heat from the interior thereof to the outside

surroundings. To illustrate the effectiveness of an insulated structure comprising aerogel as the insulator, ice cream under standard practices was kept in the container shown and described in Figures 1 and 2 for a period of twenty-four hours during which period it was too hard to serve but following which period the ice cream was in right condition to be served for a period of twelve hours thereafter; whereas, in connection with cabinets now in use and insulated with previously known solid insulators, and otherwise under the same standard conditions, using the same amount of refrigerent the ice cream during the first twelve hour period was too soft for serving and considered unsatisfactory.

Operating over a period of four months during the summer, under exactly the same conditions, it was found that the silica aerogel insulated cabinet reduced the consumption of dry ice 20 to 30 per cent over that used by the cabinet insulated with the solid material which is the best of those previously known. In addition, the efficiency of the aerogel as a thermal insulator permits an increase in the size of ice cream cabinets so that they may advantageously compete with electrical refrigeration, especially in smaller stores which have a lesser volume of trade. "Brine slugs" are a desirable form of refrigeration for this type of cabinet. When they are used in a cabinet containing the best previously known solid insulation it is necessary to chill them to —140° F. prior to use, necessitating special apparatus.
When an aerogel is used for insulation under the
93 same conditions, a chilling temperature of 50° F. is
all that is required. Since all ice cream manufacturing plants have a hardening room maintained at this temperature no additional apparatus is necessary.

An aerogel is equally advantageous when used as an insulator for refrigerators, both the household and larger store models. I prefer that all the joints of the refrigerator be cemented but this is not necessary. The efficiency of the aerogels as thermal insulators permits a material reduction often of the order of 50 per cent, in the insulation thickness with no sacrifice of efficiency so there is a larger useful refrigerating space inside for any given outside dimensions. Some manufacturers of insulated apparatus use "shaped" insulation, compelling them to stock many sizes and forms. The use of free flowing powdered or granular aerogels simplifies the application of the insulating material to the structure to be insulated and eliminates the present inconvenient stocking of various shapes.

In addition aerogels are also of outstanding utility when used as thermal insulation for tank cars in which liquid oxygen, liquid air or similar materials are shipped. The low temperatures encountered do not make them more brittle and substantial savings result from their use.

The aerogels are also of advantage when used to replace charcoal in larger sized vacuum thermos bottles. In addition to providing the increase in structural strength furnished by charcoal the aerogel will add to the thermal efficiency.

94 Aerogels also give outstanding results when used as thermal insulators for ovens, furnaces, heaters or other heat producing or heat-exchange units. Where the unit is not already so constructed, it is desirable to make all the joints tight so as to prevent loss of the insulator by sifting. Since aerogels possess a low heat capacity in addition to their very low thermal conductivity, they are especially advantageous for apparatus which is being constantly heated and cooled, such as home and bakery ovens, laboratory furnaces, pottery kilns, etc. This property permits quick heating of the oven to the desired temperature with resulting savings in time and fuel.

Of course the aerogels also have the advantage noted in other connections of permitting high thermal insulating efficiency with thin layers of insulation, which is important where space is limited but this is of additional importance where small units, such as laboratory equipment, are to be insulated. Heat losses from such units are increased by a large increase in outside area due to the necessary thick layer of insulating material where inefficient insulators are used so as to at least partially nullify the increased thermal efficiency normally resulting from the use of such an insulator. The proper performance of experimental reflux columns, constant temperature baths, apparatus for the study of reaction temperatures, etc. is dependent on reducing heat losses to a minimum so aerogels are of especial value when used for these purposes.

95 In addition to the properties of aerogels outlined above their virtual non-compressibility, once they have been packed into the space provided for them enables them to support considerable weight and they can be employed where structural strength is necessary. Their extreme lightness permits their use where weight must be kept at a minimum and the fact that many inorganic aerogels may be prepared in addition to the organic aerogels makes it possible to employ the one made from the materials which are most easily available at that time and place and consequently are least expensive.

Where the term "aerogel" appears in the present specification and claims it will be understood that I mean products similar to those prepared by the method disclosed in my copending application, Serial No. 746,412, filed October 1, 1934. Such products are distinguished by their extreme lightness, very low thermal conductivity and low heat capacity as well as by their finely divided, dry and free flowing properties.

It will be readily apparent to those skilled in the art that I have provided a method and means for thermally insulating a large number of different types of structures more effectively so that the volume and weight of insulator required are substantially reduced thus permitting the manufacture of structures having a larger insulated space for any given outside dimensions. My invention is not limited to any specific embodyment described herein but only by the scope of the appended claims.

96 What I Claim is:

1. A thermally insulated structure comprising, at least, two spaced walls having an inorganic aerogel disposed in the space therebetween as a thermal insulator.

2. In an insulated structure having heated material in the interior thereof, said insulated structure comprising spaced walls surrounding the heated material, at least in part, the space between said walls being filled with an inorganic aerogel in intimate contact with the surfaces of said walls.

3. In an insulated structure having cooled material in the interior thereof, said insulated structure comprising spaced walls surrounding the cooled material, at least in part, the space between said walls being filled with aerogel in intimate contact with the surfaces of said walls.

4. An insulated structure comprising, at least, two spaced walls having an inorganic aerogel disposed in the space therebetween and in contact with said walls, the inorganic aerogel being in sufficiently fine state of sub-division to give it flowing properties whereby it may be poured into the space between the walls.

5. An insulated structure comprising, at least, two spaced walls having silica aerogel disposed in the space there-
between and in contact with said walls, said silica
97 aerogel being in sufficiently fine state of sub-division
to occupy substantially all of the space between the
walls.

6. The method of thermally insulating structures which includes the steps of providing an enclosed space substantially surrounding the structure and filling the space with silica aerogel in a sufficiently fine state of subdivision to flow into said space.

7. The method of thermally insulating structures which include the steps of providing an enclosed space substantially surrounding the structure, filling the space with silica aerogel in a sufficiently fine state of sub-division to flow into said space, and sealing said space.

8. The method of thermally insulating structures which includes the steps of providing an enclosed space substantially surrounding the structure, filling the space with silica aerogel, evacuating said space and then hermetically sealing the space.

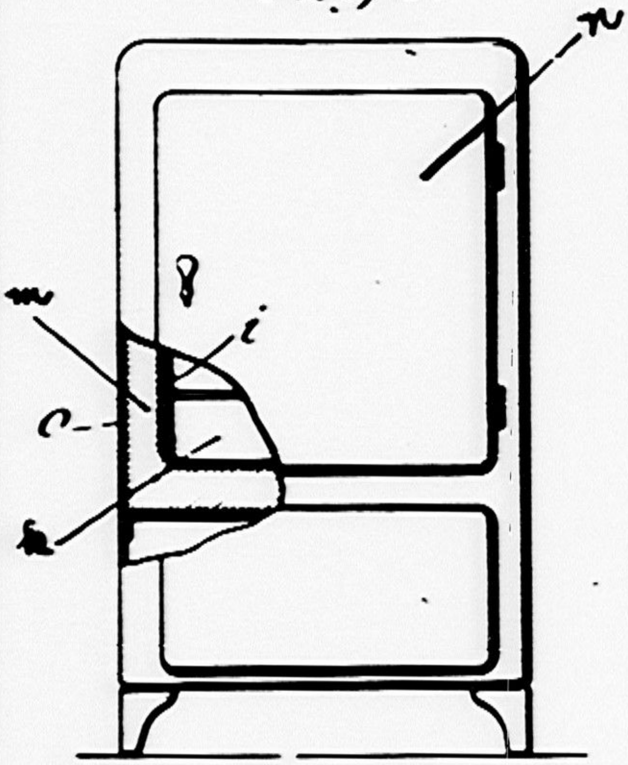
9. A thermally insulating container comprising inner and outer shells of similar shape, the inner shell being of less dimension than the outer shell and supported out of contact with the walls of the outer shell, aligned openings in said shells, a wall of insulating material extending between the edge portions of said openings, silica aerogel dis-
98 posed in and filling the space between said inner and outer shells, a shelf disposed in the inner shell and supported between the upper and lower ends thereof, the space below the shelf being adapted to contain a refrigerant and the space above the shelf being adapted to support the substances to be kept cooled, and a cover for said openings.

10. A thermally insulated bottle comprising a receptacle and a closure therefor, said receptacle being surrounded by a jacket, said jacket comprising two spaced walls of a shape substantially conforming to the shape of said receptacle, silica aerogel disposed in and filling the space between said walls, and a cap for said jacket overlying the closure of said receptacle.

11. A thermally insulated bottle comprising a receptacle and a closure therefor, said receptacle being surrounded by a jacket, said jacket comprising two spaced walls of a shape substantially conforming to the shape of said receptacle, silica aerogel disposed in and filling the space between said walls, a cap for said jacket overlying the closure of said receptacle, said space between the walls of said jacket containing aerogel being evaculated.

* * * * * * * * * *

Fig. 1.



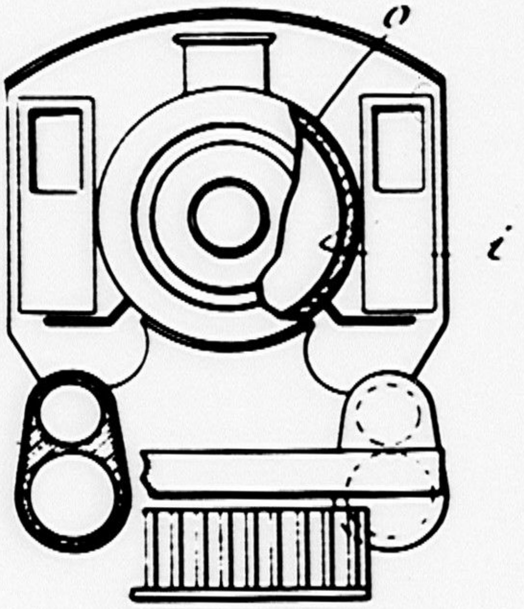
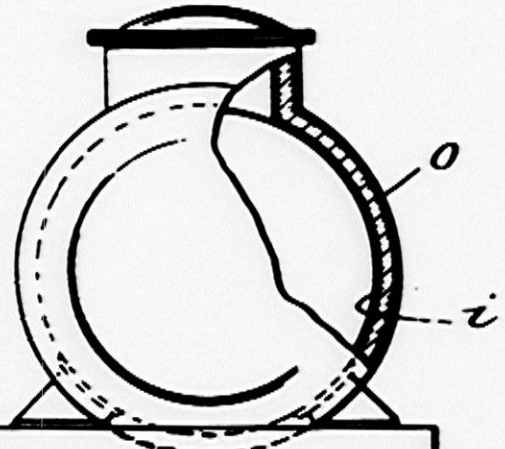


Fig. 6.

Fig. 5.



Inventor

Samuel S. Kistler.

By

Attorney

APPELLEE'S EXHIBIT NO. 1.

222 Endorsed: Filed Apr. 22, 1943 Charles E. Stewart, Clerk

KISTLER v. COE

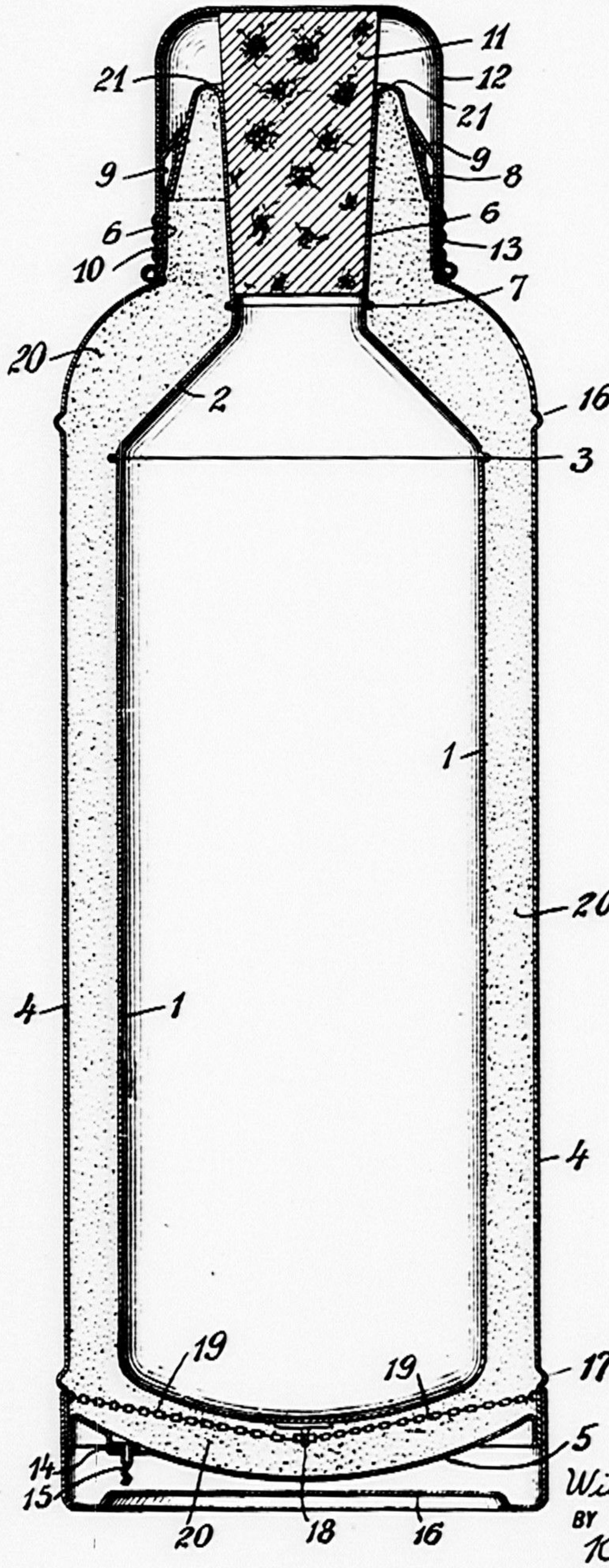
Civil Action No. 13,971

A—Stanley,	1,071,817
B—Schellens,	2,038,763
C—Kistler,	2,093,454
D—Print of Drawings,	
E—Examiner's Statement,	
F—Decision of the Board of Appeals	

* * * * * * * * * *

W. STANLEY.
HEAT INSULATED RECEPTACLE.
APPLICATION FILED AUG. 5, 1912.

1,071,817. Patented Sept. 2, 1913.



WITNESSES
John O. Gempler
George Schlatt

INVENTOR
William Stanley
BY
Kenyon & Kenyon
ATTORNEYS

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UNITED STATES PATENT OFFICE.

WILLIAM STANLEY, OF GREAT BARRINGTON, MASSACHUSETTS.

HEAT-INSULATED RECEPTACLE.

1,071,817. Specification of Letters Patent. **Patented Sept. 2, 1913.**

Application filed August 5, 1912. Serial No. 713,245.

To all whom it may concern:

Be it known that I, William Stanley, a citizen of the United States, and a resident of Great Barrington, Berkshire county, State of Massachusetts, have invented certain new and useful Improvements in Heat-Insulated Receptacles, of which the following is a specification.

My invention relates to heat insulating barriers and more particularly to the insulation of receptacles having an inner shell surrounded by an outer shell with a vacuous space therebetween and commonly known as vacuum bottles etc. My invention, however, may be applied to milk cans and many other devices and arrangements.

The common vacuum receptacle has its shells or walls constructed of glass and accordingly such receptacles are very liable to breakage and cannot withstand hard usage. Moreover, it is found that a very high degree of exhaustion must be maintained in the vacuous space in order to get sufficient heat insulation to make the devices practicable for ordinary uses. Furthermore, because such receptacles are made of glass they are limited in size.

The main objects of my invention are to overcome one or more of these difficulties or disadvantages.

In order to produce bottles which are not liable to breakage it has been suggested that the shells be constructed of metal instead of glass but such bottles have been found entirely unsuccessful because the high degree of exhaustion required is not maintained in the vacuous space, probably because under the greatly reduced pressure the metal gives off gas for a long time which reduces the degree of exhaustion to such an extent that the bottles have not great enough insulating powers to render them usable for most purposes, so that they are entirely impracticable. In order to overcome these difficulties I fill the vacuous space with a finely divided material which will not give off any material amount of gas to materially change the gaseous pressure in the exhausted space. If the space be filled with such a material the same degree of heat insulation may be obtained at a much less reduced gaseous pressure (*i. e.*, much less exhaustion) in the vacuous space, and the said much less reduced pressure will be maintained substantially constant even in a vessel constructed with metallic shells, probably because the metal does not give off a sufficient amount of gas to materially change the reduced gaseous pressure in the vacuous space. I preferably, however, use a finely divided substance which will not only not give off gas in the vacuous space, but will have in addition the power of absorbing any small amount of gas given off to the vacuous space by the metal shells.

I am aware that it has been suggested that the vacuous space of a receptacle of the class in question be filled with a finely divided substance, but in every such case, as far as I am aware, the material has been of a character to give off gas in the vacuous space so that in time the exhaustion and heat insulation powers became so reduced that the receptacles became practically inoperative and entirely unfit for the purposes for which they were intended. It is therefore important that the finely divided material be of a character such that it will not give off any material amount of gas in the vacuous space.

As stated above, a high degree of exhaustion is required to insulate the (glass) vacuum bottle of commerce. In my bottle a much lower vacuum is required, because it is only necessary to exhaust the spaces, voids, or cavities left in the filling material (which voids or cavities are of a microscopic order of magnitude) to a point at which the average distance between all the molecules of the residual gas is approximately equal to the diameter or distance across the voids, high thermal insulation being thus obtained when the order of magnitude of the pressure of the residual gas is one hundred times as great as the residual gaseous pressure in the common exhausted bottle of commerce. In other words, the introduction of properly chosen finely divided filling material may permit the exhaustion to be one hundred times less than is necessary if no such filling is used. A still greater exhaustion will increase to some extent the insulation, but it is rarely necessary. The degree of exhaustion necessary to produce a given insulation depends upon the fineness of division of the material. It will, however, be clear that the use of such a finely divided substance, which will not give off gas or one which will absorb gas in the vacuous space, is of

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special importance if the receptacle be constructed with metallic shells.

Further objects, features and advantages will more clearly appear from the detailed description given below taken in connection with the accompanying drawing which forms a part of this specification. The drawing shows a vertical section of a vacuum bottle embodying my improvements in one form.

Referring to the drawing, 1 represents an inner steel cylindrical shell provided with a top portion 2 welded thereto at 3. The body of the shell 1 is cylindrical in shape. Extending symmetrically about the inner shell is an outer metal cylindrical shell 4 having a bottom 5 secured thereto. The two shells are connected together entirely around the mouth of the receptacle by means of a steel neck 6 welded to the top 2 at 7, and secured to the outer shell 4 at 8, so as to form a space between the two shells which may be suitably exhausted. The inner surfaces of the shell 1 with its top 2 and neck 6 are covered with any suitable or well known vitreous or vitrified coating such as enamel, etc., or they may be tinned or covered with a protecting varnish or the like, in order that the inside of the vessel may be protected and easily kept clean and sanitary.

Extending about the neck of the bottle is a circular piece 9 having its lower portion threaded at 10. For closing the mouth of the bottle a stopper 11 of cork or other suitable material is inserted therein, and over this is placed a metallic cup-shaped cap 12 threaded at its lower portion 13 for engagement with the screw threads at 10. The bottom 5 is recessed at 14 and provided with a metal tube 15 through which the space between the shells may be exhausted (say to .01—m. m.). and after exhaustion the tube is crimped and soldered to effectively seal the vacuous space. A lower base or bottom 16 is secured to the outer shell 4 after exhaustion to complete the receptacle. The outside surfaces of the receptacle may be nickeled and beads 16 and 17 provided in the shell 4 to strengthen the receptacle. In order to more securely hold the lower end of the inner shell 1 in place with respect to the outer shell, I provide a spider connecting the two shells, which consists principally of a projection 18 secured to the bottom of the inner shell and small links, wires or chains 19 connecting this projection with the outer shell 4. The links, wires or chains 19 are of so high thermal resistance that their heat conducting power is negligible.

Before putting on the bottoms 5 and 16 the space between the shells is filled with a finely powdered material 20 chosen or prepared so as not to give off any material amount of gas at ordinary temperatures at which such receptacles are designed to be used. For this purpose sublimed silica forms a good substance and may be used with success. By filling the vacuous space with this material a very high degree of heat insulation may be obtained with a much less reduction of gaseous pressure than ordinarily employed, as any small amount of gas given off by the metallic walls under these conditions will not materially affect the gaseous pressure and corresponding heat insulation.

Obviously other substances may be used to fill the vacuous space. Even materials which are ordinarily good heat conductors if in sufficiently finely divided condition, may be used. Such substances as metallic oxids, finely divided metals, etc., may be used, the nature of the filling substance being quite immaterial provided it is sufficiently divided and will not give off gases (including vapors) after the exhaustion.

If desired, a finely divided substance may be used which will not only not give off gas to the vacuous space but will have an appetite for gas or the power of absorbing gas under the conditions of use. A suitable material for this purpose is finely divided carbon which has been highly heated to remove occluded gases and also heated in the vacuous space at the time of exhaustion to a temperature higher than the temperature at which the receptacle is to be generally used. The carbon so treated will thereafter absorb any small amounts of gas given off to the vacuous space by or from the metallic shells and thus aid in keeping up the exhaustion necessary for proper insulation. The carbon will so act even when hot materials are placed in the receptacle, since it is necessary to heat the carbon nearly to the temperature at which it was heated at the time of exhaustion before it will cease to absorb gases from the vacuous space. Obviously various other gas absorbing materials may be employed with success.

Successful receptacles constructed of metallic shells may be produced by the use of such gas absorbing materials in the vacuous space even although the space is not filled with them. Since however in such case the degree of exhaustion must be much greater in order to produce the same degree of heat insulation I prefer to practically fill the vacuous space with the finely divided substance. A certain amount of heat transmission through the sides and neck of a receptacle of the class described is usually permissible but by reducing the losses through the neck the same insulation value of the receptacle may be maintained with a greater gaseous pressure (less exhaustion) in the vacuous space whereby any small amount of gas which may be given off to the space by the metallic parts will not make such a

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great percentage of change in the gaseous pressure and the degree of insulation is more nearly maintained constant. In order to reduce the losses through the neck to bring about this result, I provide the receptacle with a long narrow neck 6 extending from the seam 7 to the top 21. The neck though of metal, yet being long and narrow has such a high thermal resistance that the losses therethrough are small. By increasing the amount of exhaustion however, the high resistance feature of the neck may be omitted.

Although I have described my invention with respect to certain particular embodiments thereof, nevertheless I do not desire to be limited to the particular details shown and described except as clearly specified in the appended claims, since many changes, modifications and substitutions may be made without departing from my invention in its broader aspects and my invention in its broader aspects may be found useful in many other applications thereof.

Having fully and clearly described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A heat insulating barrier comprising two metallic walls suitably connected and spaced apart, the space between said walls being filled with finely divided material which will absorb gas at ordinary temperatures and reduced pressures, the said space being exhausted to such a degree as to greatly reduce the conductivity for heat between the two metallic walls.

2. A heat insulated receptacle having an inner metallic shell with a vitreous coating on its inner surface and an outer metallic shell extending about the inner shell and spaced therefrom and connected to the inner shell at the mouth of the receptacle by a metallic neck of high thermal resistance, the space between said shells being filled with finely divided material substantially incapable of giving off gas but which will absorb gas at ordinary temperatures and reduced pressures, and the said space also being exhausted to such a degree as to greatly reduce the conductivity for heat between the two shells.

3. A heat insulating barrier comprising two walls suitably connected and spaced apart to form a vacuous space therebetween, said space containing finely divided material substantially incapable of giving off gas at ordinary temperatures and reduced pressures, and the said space being exhausted to such a degree as to greatly reduce the conductivity for heat between the two walls.

4. A heat insulated receptacle having an inner metallic shell and an outer metallic shell extending about the inner shell and spaced therefrom and connected to the inner shell at the mouth of the receptacle by a metallic neck of high thermal resistance, and the space between said shells being filled with finely divided material substantially incapable of giving off gas at ordinary temperatures and reduced pressures, and the said space also being exhausted to such a degree as to greatly reduce the conductivity for heat between the two shells.

5. A heat insulated receptacle having an inner metallic shell and an outer metallic shell extending about the inner shell and spaced therefrom and connected to the inner shell at the mouth of the receptacle, the space between said shells being filled with finely divided material incapable of giving off gas at ordinary temperatures and reduced pressures, and the said space also being exhausted to such a degree as to greatly reduce the conductivity for heat between the two shells.

6. A heat insulated receptacle having an inner shell, and an outer shell extending about the inner shell and spaced therefrom and connected to the inner shell at the mouth of the receptacle, and the space between said shells being filled with finely divided material which will absorb gas at ordinary temperatures and at the reduced pressures of the space, the said space also being exhausted to such a degree as to greatly reduce the conductivity for heat between the two shells.

7. A heat insulated receptacle having an inner shell, and an outer metallic shell extending about the inner shell and spaced therefrom and connected to the inner shell at the mouth of the receptacle by a neck of high thermal resistance, and the space between said shells being filled with finely divided material which will absorb gas at ordinary temperatures and reduced pressures, and the said space also being exhausted to such a degree as to greatly reduce the conductivity for heat between the two shells.

8. A heat insulating barrier comprising two walls suitably connected and spaced apart to form a vacuous space therebetween, said space being filled with finely divided material substantially incapable of giving off gas at ordinary temperatures and reduced pressures, and the said space being exhausted to such a degree as to greatly reduce the conductivity for heat between the two walls.

9. A heat insulated receptacle having an inner metallic shell and an outer metallic shell extending about the inner shell and spaced therefrom and connected to the inner shell at the mouth thereof, the space between said shells being exhausted and filled with a finely divided material which has been heated in the space at the time of exhaustion to a temperature higher than the ordinary temperatures at which the receptacle is to be generally used, whereby

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the material is adapted to absorb gas from the space at ordinary temperatures at which the receptacle is to be generally employed.

10. A heat insulated receptacle having an interior metallic shell and an exterior metallic shell extending about the inner shell and spaced therefrom and connected to the inner shell at the mouth of the receptacle by a neck of high thermal resistance, the space between said shells containing finely divided material which has been heated in the space at the time of exhaustion to a temperature higher than the ordinary temperatures at which the receptacle is to be generally used, whereby the material is adapted to absorb gas from the space at ordinary temperatures at which the receptacle is to be generally used, said space being exhausted to such a degree as to greatly reduce the conductivity for heat between the two shells.

11. A heat insulated receptacle having an interior metallic shell and an exterior metallic shell extending about the inner shell and spaced therefrom and connected to the inner shell at the mouth of the receptacle, the space between said shells containing finely divided material which has been heated to a temperature higher than the ordinary temperatures at which the receptacle is to be generally used, whereby the material is adapted to absorb gas from the space at ordinary temperatures at which the receptacle is to be generally used, said space being exhausted to such a degree as to greatly reduce the conductivity for heat between the two shells.

12. A heat insulated receptacle comprising metallic walls, suitably joined, embracing a vacuous space filled with finely divided material which will not give off gas to the space at ordinary temperatures, said space being exhausted to such a degree as to greatly reduce the conductivity for heat across said space.

13. A heat insulated receptacle comprising spaced metallic walls suitably joined to form a vacuous space, said space being filled with material leaving voids or cavities of a microscopic order of magnitude and the number of which is practically infinitely large, said material being of a character not to give off gas to the space between the walls and said space being exhausted of gas to such an extent as to separate the molecules of gas by an average distance at least as great as the average distance across said voids or cavities.

14. A heat insulated receptacle comprising spaced walls, suitably joined, to form a vacuous space therebetween, said space being filled with a finely divided substance which will not give off gas in the vacuous space at ordinary temperatures and which leaves voids or cavities of a microscopic order of magnitude and the number of which is practically infinitely large, said voids or cavities being exhausted of gas only to about such an extent as to separate the molecules of gas by an average distance greater than the average distance across said voids or cavities.

15. A heat insulating barrier comprising two walls suitably connected and spaced apart to form a vacuous space therebetween, said space containing finely divided material which will absorb gas at the ordinary temperatures and reduced pressures, the said space being exhausted to such a degree as to greatly reduce the conductivity for heat between the two walls.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

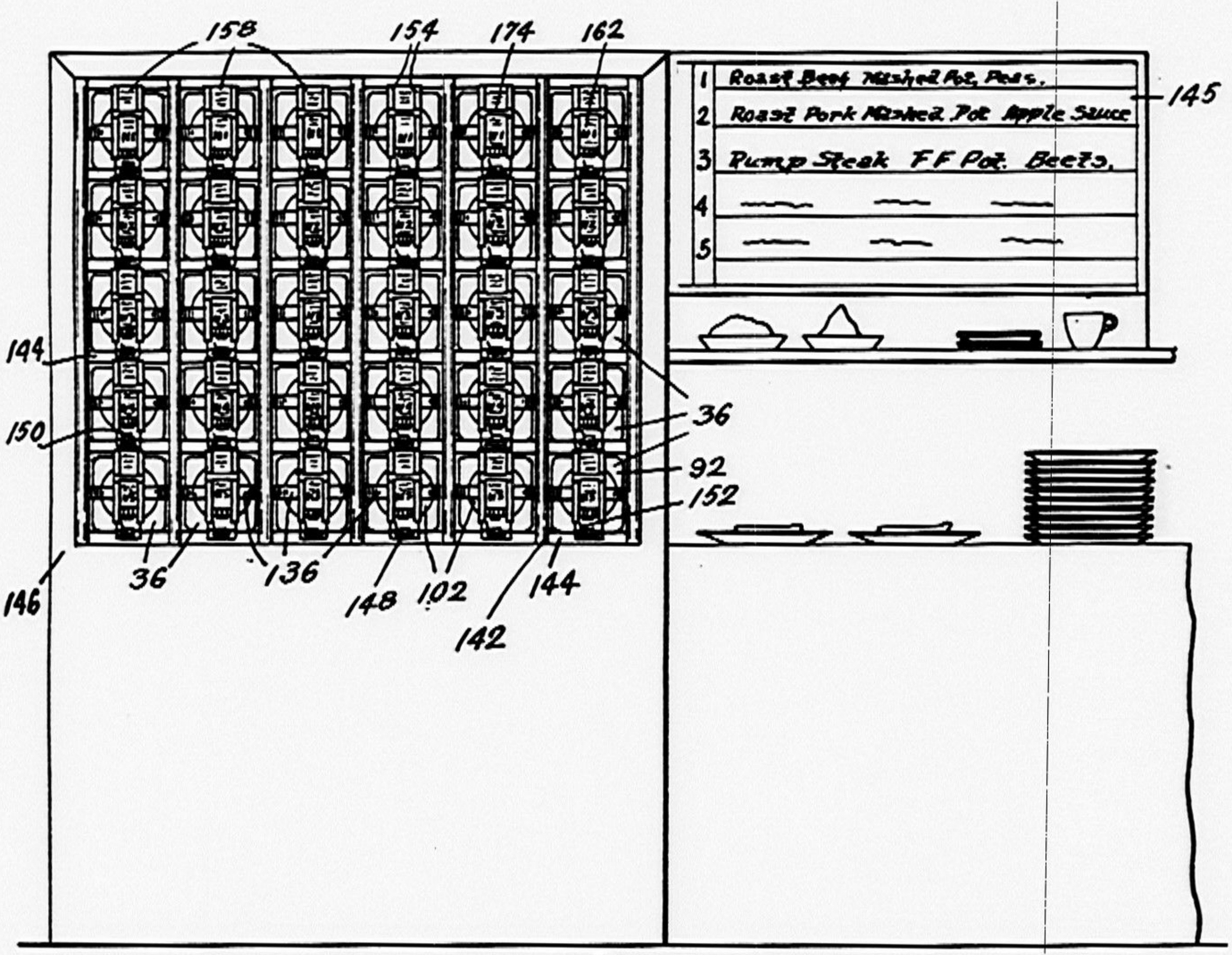
WILLIAM STANLEY.

Witnesses:
C. P. RANDOLPH,
F. G. LARAMEE.

April 28, 1936. E. L. SCHELLENS 2,038,763

HEAT INSULATING FOOD CONTAINER

Filed March 8, 1933 3 Sheets-Sheet 1


158
154
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1 Roast Beef Mashed Pot. Peas.
2 Roast Pork Mashed Pot. Apple Sauce
3 Rump Steak F F Pot. Beets.
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Fig. 1.

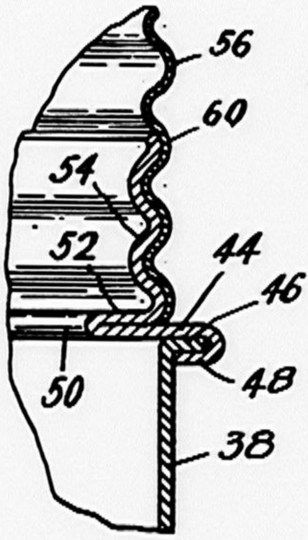

Fig. 15.

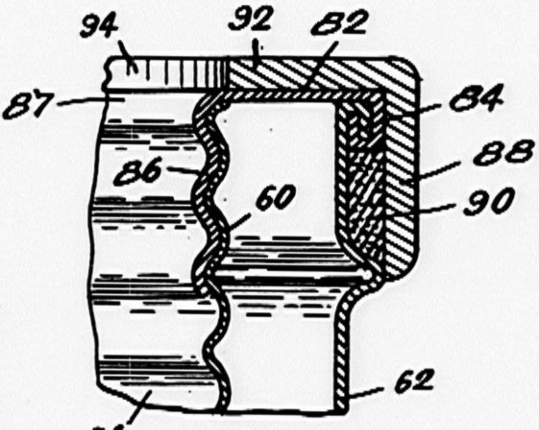

Fig. 16.

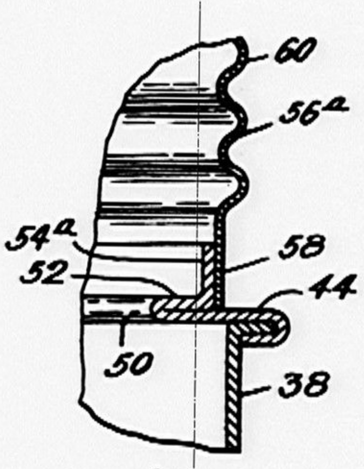

Fig. 17.

Inventor.
Eugene L. Schellens
by
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atty

71

April 28, 1936. E. L. SCHELLENS 2,038,763

HEAT INSULATING FOOD CONTAINER

Filed March 8, 1933 3 Sheets-Sheet 2

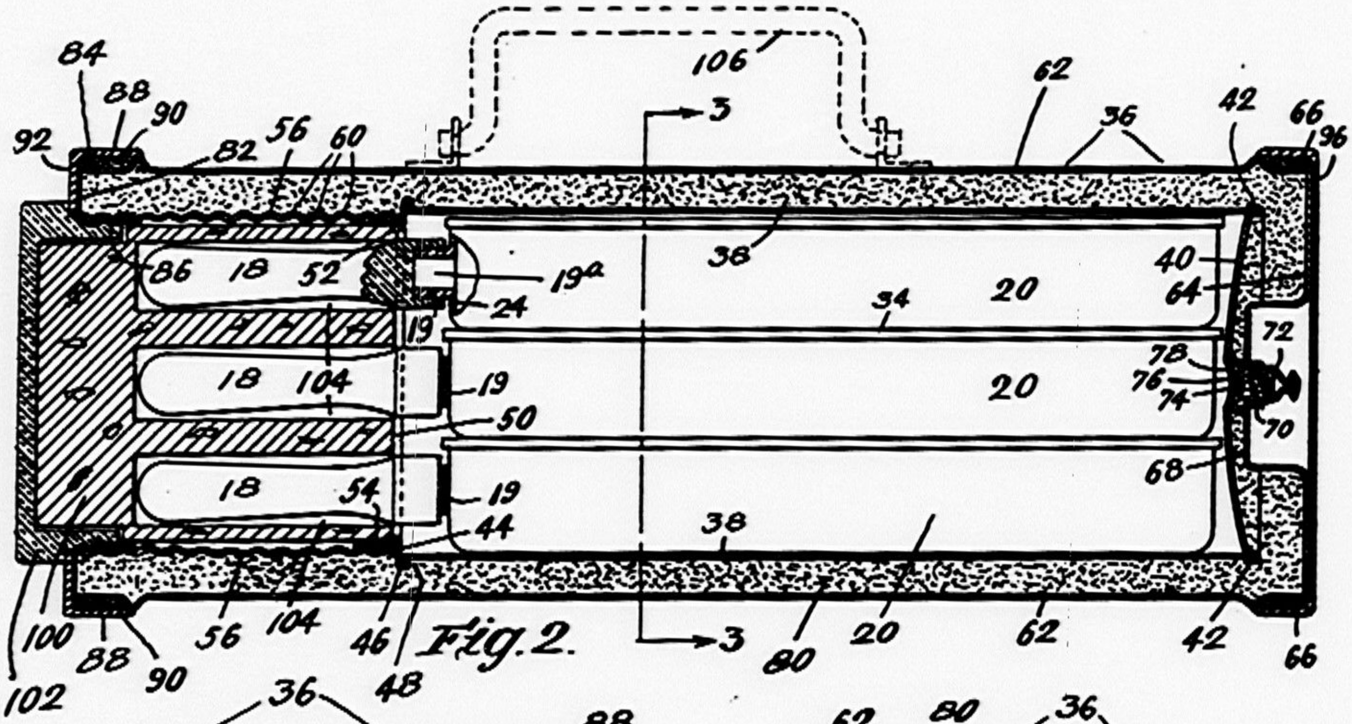

Fig. 2.

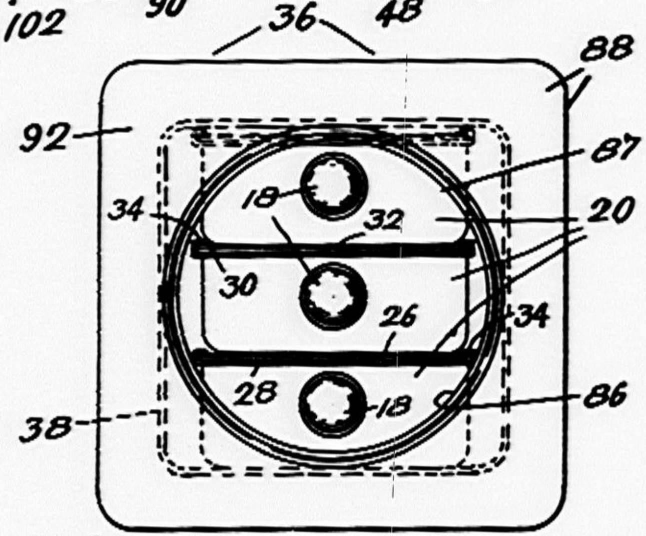

Fig. 4.

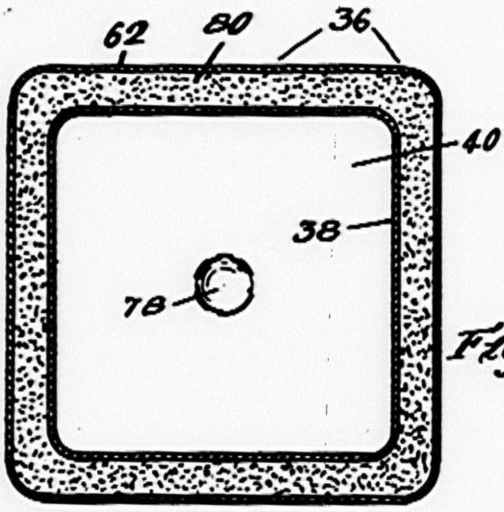

Fig. 3.

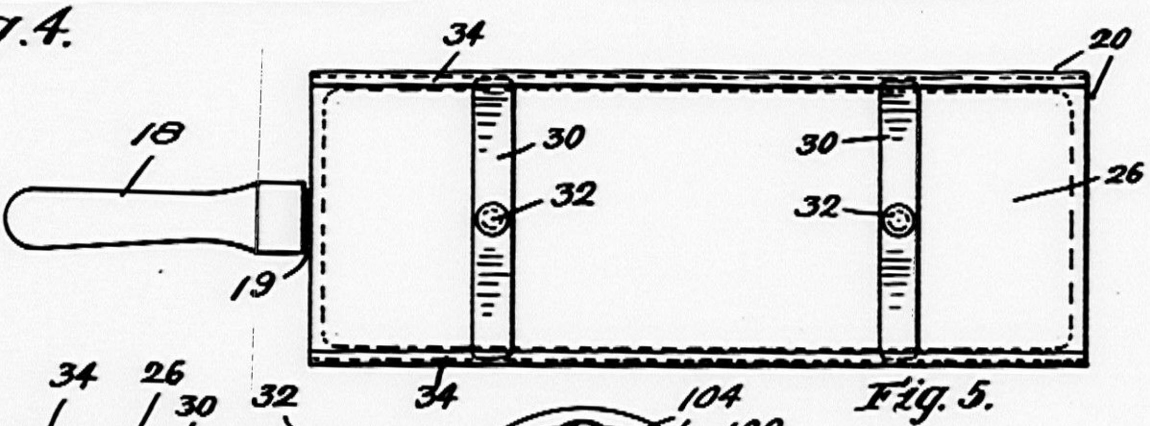

Fig. 5.

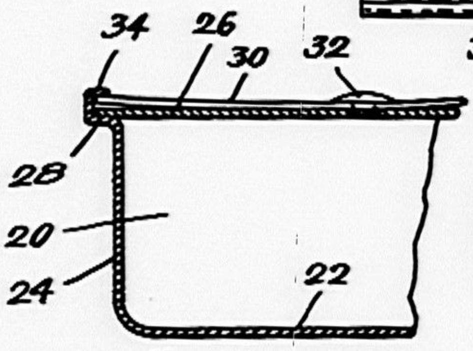

Fig. 6.

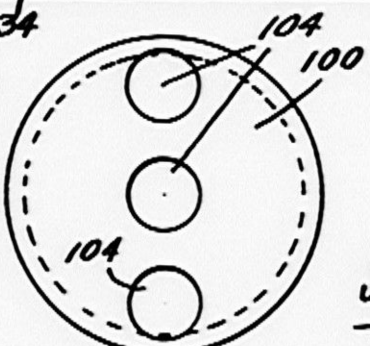

Fig. 7.

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April 28, 1936. E. L. SCHELLENS **2,038,763**

HEAT INSULATING FOOD CONTAINER

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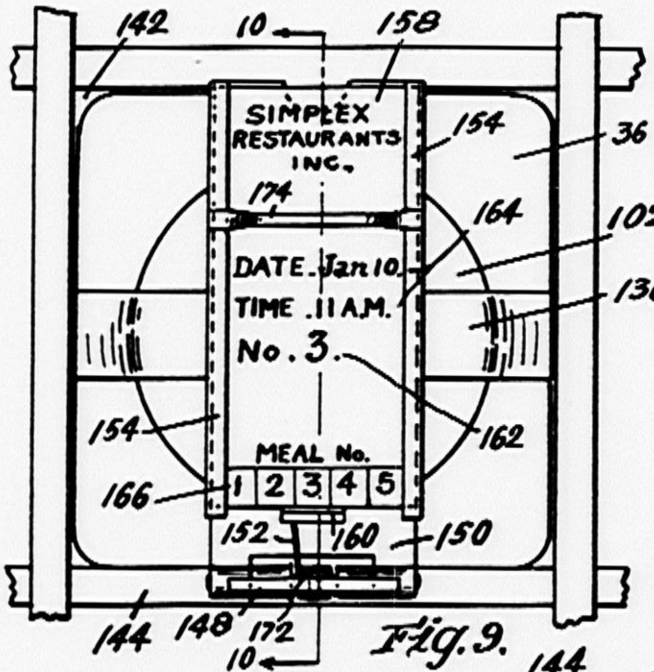

Fig. 9.

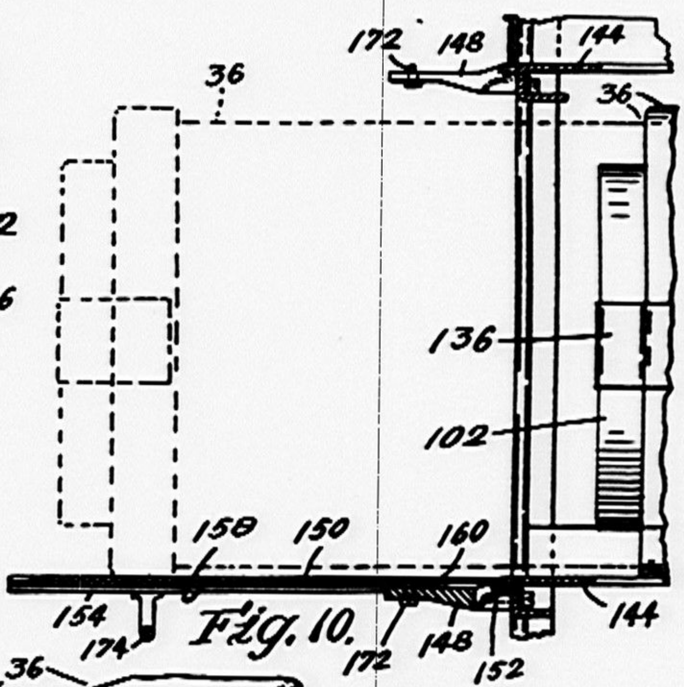

Fig. 10.

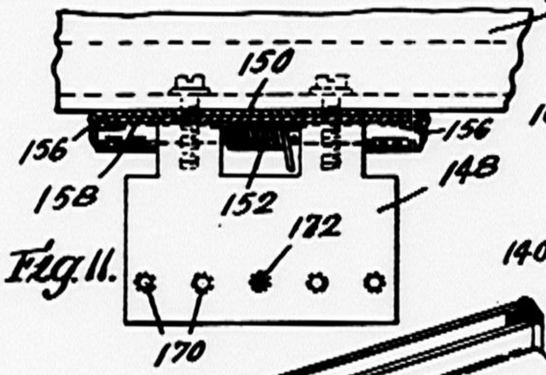

Fig. 11.

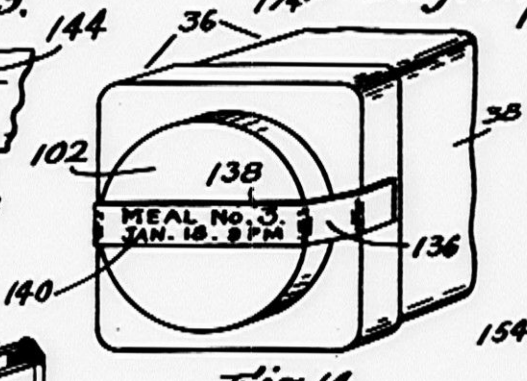

Fig. 14.

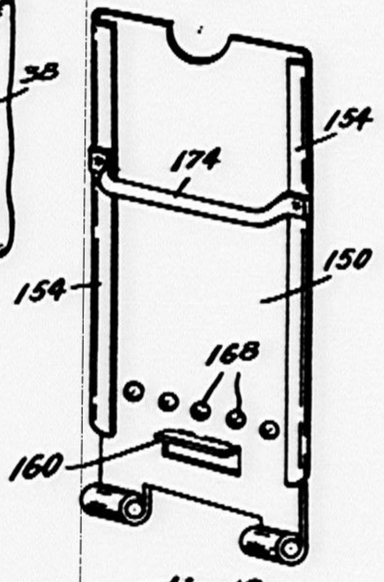

Fig. 12.

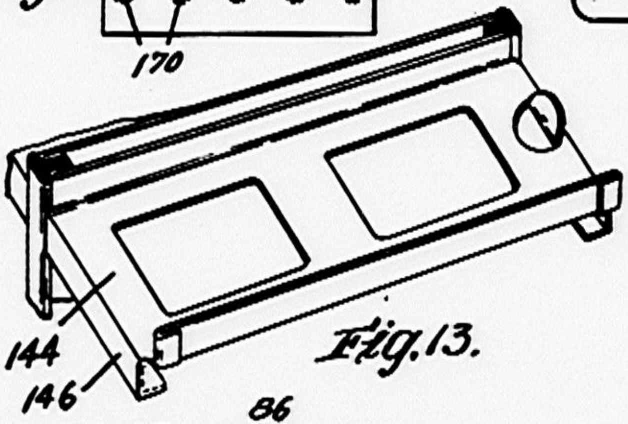

Fig. 13.

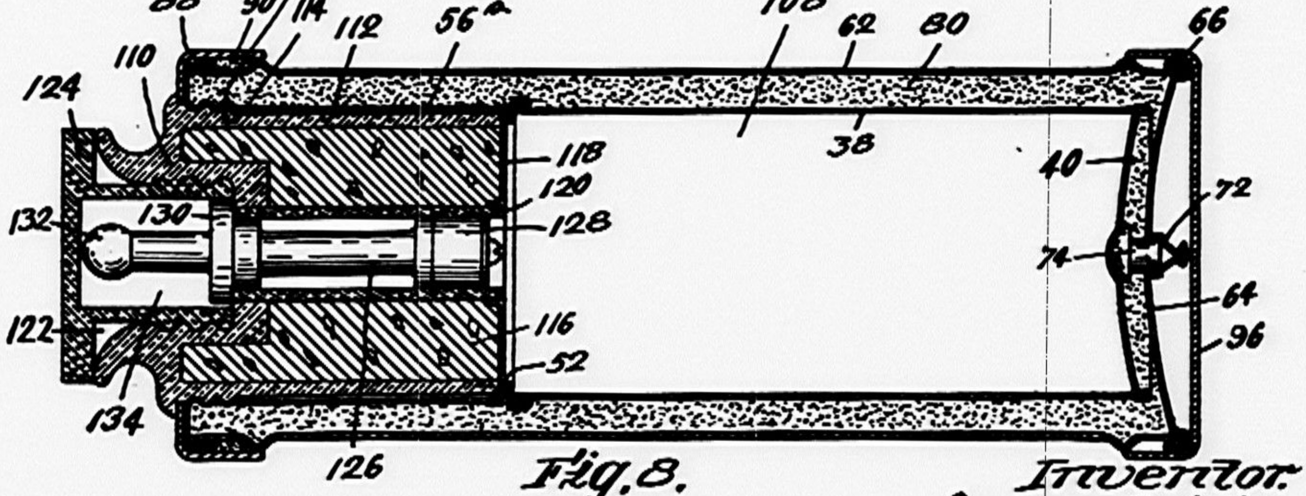

Fig. 8.

Inventor.
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Patented Apr. 28, 1936 **2,038,763**

UNITED STATES PATENT OFFICE

2,038,763

HEAT-INSULATING FOOD CONTAINER

Eugene L. Schellens, Ridgewood, N. J., assignor to The Shellwood-Johnson Company, Paterson, N. J., a corporation of New Jersey

Application March 8, 1933, Serial No. 660,073

4 Claims. (Cl. 220—9)

This invention relates to heat-insulating food containers.

In restaurant systems and especially systems where one organization operates several restaurants and especially those of the "quick service" type it is customary to prepare a large amount of the food sold at the restaurants at a central kitchen and to distribute the foods to the various restaurants where the hot foods are kept hot by the use of steam tables, until served to the customer. Due to the fact that the food is kept open at the steam table the food loses a large amount of the juices that carry the flavor of the food so that the food that is served to the customer is generally flat and more or less tasteless or at least does not have the full flavor present in food that is cooked in the home and served immediately after cooking. There is, furthermore, a marked loss in flavor in transporting the food from the central kitchen to the restaurants since the volatile flavor liquids escape from the loosely covered food containers in transport and since the hot foods become cool in transport and are then reheated at the steam tables. The cooling and subsequent reheating of the food ordinarily does not improve the flavor. Hence it is an object of this invention to provide a method and system of food distribution particularly adapted for hot foods, or those the temperature of which should be preserved, wherein the hot foods, and particularly individual portions of the foods are packed at the central kitchen in substantially tight receptacles when hot or at the proper temperature and the receptacles are stored in heat insulating containers and are transported in these containers to the restaurants and are kept at the restaurants in these containers until the food is served to the customer. In this way the flavor of the food is retained and the temperature of the food is maintained approximately constant up to the time it is served to the consumer.

It is common practice for restaurants to provide a certain variety of meals, say, four or five, each meal consisting of two or three different foods, usually a meat, potatoes and a vegetable, and the various meals comprising different food combinations. The present invention is particularly adapted for the distributing of such meals from a central kitchen to a plurality of restaurants and the dispensing thereof at the restaurants. In applying the present invention to the distribution, storage and ultimate dispensing of such meals my method is essentially as follows: The various foods are cooked or otherwise prepared at the central kitchen and individual portions of the foods are immediately prepared and placed in separate receptacles or covered trays, that may have been previously heated, which are immediately sealed to prevent the escape of volatile flavor essences. The filled receptacles are grouped, say, in three's to provide individual meals of the different foods and the foods in the receptacles of the various groups may be varied to provide several combinations of individual meals. The group of receptacles which contain the hot foods for a certain meal are placed in a heat-insulating container, preferably of the vacuum type, the container having some identifying mark as a number by which the nature of the combination of its contained foods can be ascertained readily. The heat-insulating container preserves the heat of the food therein for many hours. The various containers, containing different individual meals, are dispatched to the various restaurants and are placed on shelves in such manner that the identifying marks, and hence the nature of the contents thereof, can be ascertained readily by a customer. The containers are preferably stored on the shelves in groups each each containing the same meal and a menu is associated with the groups of containers so that a customer can select from the menu the particular meal that he favors and also ascertain the identification mark of the container that carries the meal. The customer then removes the selected container from the shelf and takes it to a table where he opens the container, withdraws the individual receptacles, placing the food therein on a plate or plates and there consumes it. Preferably the individual containers have checks or tickets associated therewith which the customer is required to present to the cashier for payment, the check identifying the nature and thereby the price of the meal and the arrangement being such that the check is punched or otherwise marked in the act of removing the container from the shelf, to prevent fraud. This method of food distribution has many advantages over the present system. The food is placed hot in the receptacles immediately it is prepared and sealed in the receptacles so that there is no harmful loss of flavor from the food. If desired certain foods can be placed hot but not entirely cooked in the receptacles and the cooking can be completed by the inherent heat stored in the food and the receptacles and present by the vacuum-insulated container. The heat-insulating containers preserve the heat of the food over a long period of time so that there is

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no loss of heat and thereby of flavor in transport. A large number of meals can be stored on shelves in a relatively small space so that more room is made available for the accommodation of customers. Less help is required in attending the wants of the customers. There is improved cleanliness and less wastage of food than heretofore. The customer has the assurance that the food has had a minimum exposure to contaminating influences.

My invention also comprehends a special form of food receptacle and a heat insulating storage container for a series of the trays and also apparatus for automatically punching a customer's ticket or check as a part of the act of removing a container from its storage shelf.

Fig. 1 is a front elevation of a storage shelf containing a number of food containing receptacles forming a part of the present invention.

Fig. 2 is a sectional elevation of one of the heat-insulating food containers of Fig. 1.

Fig. 3 is a section taken along line **3—3** of Fig. 2.

Fig. 4 is a view of the open end of the container of Fig. 2.

Fig. 5 is a plan view of one of the food receptacles of Fig. 2.

Fig. 6 is a transverse sectional detail of the food container of Fig. 5.

Fig. 7 is an end view of the stopper of the container of Fig. 2.

Fig. 8 is a sectional view of a modified form of heat-insulating container.

Fig. 9 is a front elevation of one of the container compartments of the shelf structure of Fig. 1.

Fig. 10 is a sectional detail of the front end of a container compartment taken along line **10—10** of Fig. 9.

Fig. 11 is a plan detail of the punch shelf of the container compartment of Fig. 9.

Fig. 12 is a perspective view of the check or ticket holding and container supporting plate of Fig. 9.

Fig. 13 is a perspective detail of a container supporting shelf.

Fig. 14 is a perspective detail of an end of a container and illustrating particularly the method of sealing the container and identifying the contents thereof.

Fig. 15 is a sectional detail illustrating the nature of the connections between the inner wall and the neck of the heat insulating container of Fig. 2.

Fig. 16 is a sectional detail illustrating the connections between the top portions of the outer and inner walls of the container of Fig. 2.

Fig. 17 is a sectional detail similar to Figs. 15 and 16 but illustrating a modified form of connection between the neck and the inner wall.

In accordance with the present invention individual portions of food that are hot or are at some temperature that should be preserved for rendering them most palatable for consumption, are placed in individual receptacles **20**, see Figs. 2, 4, 5 and 6, at the central kitchen. Each food containing receptacle is approximately rectangular in cross-section and is relatively long and narrow so that it can be accommodated in the evacuated heat-insulating container presently to be described and has a flat bottom wall **22** and upstanding side walls **24** and is of suitable volume to contain an individual portion of food. The receptacle is widely open at the top and is closed by a cover comprising a generally flat plate **26** which is seated upon an outstanding peripherally continuous flange **28** of the side walls and is held releasably upon said flange and in practically liquid and vapor tight engagement therewith by leaf springs **30** which are swivelled on rivets **32** of the cover and have their ends located removably under the upper flanges **34** of the receptacle and in channels of which the aforesaid flanges **28** comprise a part. The container is provided with a handle **18** which is extended in the longitudinal line of the container and is secured to an end wall thereof as by being screw-threaded removably onto a neck **19** of said end wall. Said neck can have a passage **19*a*** therethrough as illustrated in Fig. 2 which communicates with the interior of the receptacle and said handle **18** may constitute a closure for said passage. Thus the contents of the container, if liquid, can be poured out of the passage **19*a*** after the handle is removed.

A number, say, three, receptacles are stored in contiguous relation within a heat-insulating container **36**, as illustrated in Fig. 2. Said container is of the vacuum insulated type and has an inner thin metal shell **38** that is substantially rectangular in cross section, as is illustrated in Figs. 3 and 4, and has cross sectional dimensions suited to receive its designated number of food containing receptacles with but little clearance. Said inner shell is provided with a thin metal bottom wall **40** which preferably is dished inwardly to resist the pressure differences on opposite sides thereof and has a channeled periphery **42** in which the bottom end of the inner shell **38** is received. A rectangular end or cover plate **44** is seated upon the top of the inner shell and the edges of the plate and are locked together in any suitable manner and, as here shown, the top of the shell is provided with an outstanding flange **46** and the outer edge of the plate **44** has its outer edge portion **48** reflexed under the flange. The plate **44** is provided with a central circular opening **50** of as large dimensions as is practicable, the diameter of the opening being approximately as large as the cross sectional dimension of the interior of the inner shell, and large enough to admit of the passage of the food receptacles therethrough and the stacking of the receptacles one on top of the other within the inner shell. The top plate **44** is provided with a seat **52** which surrounds the opening **50** and also is provided with an upstanding ring or flange **54** which preferably is integral with the plate **44** and also preferably is screw-threaded, the threads being rolled in the ring. The inner shell is provided with a relatively long neck **56** which is preferably screw-threaded on the ring **54** and has its bottom edge seated against the top face of the plate **44**. The neck, however, need not be in screw-threaded engagement with said ring, it being sufficient to have the neck in close contact with the ring, and Fig. 17 illustrates a construction where the ring **54*a*** is free from screw-threads and is smooth and the neck **56*a*** has a smooth lower part **58** that is seated upon the top plate **44** and closely surrounds the smooth neck **54*a***. The neck **56** is preferably relatively long and is composed of thin material so that it offers a high resistance to the flow of heat along its length. Preferably the neck is screw-threaded throughout the major portion of its length or has corrugations **60** transverse the length thereof so as to provide an increased length of metal through which heat must flow from the interior of the container to an exposed dissipating surface thereby to enhance the insulating properties of the container. The container also includes an outer shell 62 that is of rectangular cross section and is spaced from and has its flat surfaces parallel with the flat surfaces of the inner shell. The outer shell also is constructed of metal. The open bottom end of the outer shell is closed by a bottom closure plate 64 of generally rectangular configuration having a double interlocking connection 66 between its marginal portions and the end portion of the shell 62. The bottom closure 64 is provided with an inset wall 68 that has a neck 70 in which an exhaust tube 72 is located. A porous plug, as a carbon plug, 74 is seated in said tube and upon the wall 68 and has its end in engagement with the bottom wall of the inner shell and so shaped as to center the inner shell in the outer shell and to hold the inner shell against lateral movement. As here shown the plug 74 has a concave inner end 76 and the bottom wall 40 of the inner shell has a convex protuberance 78 that is seated in said convexity. Preferably although not necessarily, the space between the inner and outer shells is filled with a loose heat-insulating material 80 of any suitable nature, as loose asbestos fibres, diatomaceous earth, which is packed rather solidly in the space and so supports the inner shell against displacement within the outer shell and also supports the shells against distortion due to the evacuated space and to impacts. The space between the shells is evacuated by connecting a vacuum pump to the exhaust pipe 72, the air in the space between the shells passing through the pores in the porous plug 74 and the plug holding back the particles of the insulating material. The container is conveniently sealed off from the pump by crushing the tube together and then soldering the end of the tube. The open top of the outer shell is covered by a rectangular plate 82 which is seated upon the top and has its marginal portion folded over the edge portion of the side wall to form a double interlocking connection 84 therebetween. The cover plate 82 has preferably integrally therewith an annular outstanding ring or flange 86 which defines an opening 87 in said plate, and said ring is internally and externally screw-threaded and is screw-threaded into the top of the neck 56 and thereby, through said neck, connects the top of the inner shell with the top of the outer shell. After the various parts of the container are secured together in a vacuum tight manner the top of the container is provided with a reinforcing cap 88 which snugly surrounds the end of the outer shell and is secured thereto by a body of cement 90 or other means and has a top plate 92 that overlies the top plate 82 and has a circular opening 94 therein which is aligned with and is larger than the internal diameter of the neck 56. The bottom end of the container is similarly provided with a cap 96 that overlies the bottom wall 64 and the bottom end of the shell and is similarly cemented in place. Said caps are composed of substantially thicker material than the container, or are more resistant to deformation, and serve to support the container against deformation and injury due to impacts thereon.

The precise manner in which the shells and the associated parts are connected together is not herein of extreme importance, it being sufficient to have the parts mechanically interconnected so that they will remain in their proper relation to each other while the container is treated to render it vacuum tight. The connections between the parts are not in themselves intended to be vacuum tight and any joint that is convenient and will permit the parts to be assembled easily is satisfactory.

The container is made vacuum tight preferably by the process described and claimed in my copending application Serial No. 626,384, filed July 30, 1932. In accordance with the process described in said application, small pieces of a material that has a lower melting point than the material of the container and will alloy with the container material is placed in contact with the container at the joints between the various parts. Copper is a good material for bonding the joints together and sealing all crevices, pores and passages through which leakage might occur. The container with pieces or particles of bonding material in contact therewith at the joints and other necessary parts is placed in a furnace provided with a reducing atmosphere, as hydrogen, carbon monoxide, and the like, and the container is heated at least to the melting point of the bonding material. The bonding material melts and flows over the surfaces of the container parts and enters all crevices, passages and pores by its affinity for the container material and alloys with the container material and, when the container is withdrawn from the furnace and cooled to the solidifying point of the bonding material, not only forms a vacuum tight seal for the joints and other passages through the walls but also bonds the closely associated parts strongly together. The bonding material can be laid in small pieces on the surfaces of the container near the parts to be covered with the molten bonding material or the bonding material in powder form can be distributed upon the necessary parts of the container. Preferably the entire surface of the container is bonded in the above described manner. This can be done conveniently by spraying upon the surface a liquid comprising the bonding material in powder form contained in a binder having a readily evaporating solvent. The binder can be a nitrocellulose in a suitable solvent therefor. A solution of nitrocellulose containing copper particles or powder can be sprayed onto all surfaces of the evacuated container either before the assembly of the parts thereof, so that the copper deposit is present in the various connections between the parts or it can be sprayed on after the parts have been assembled. The nitrocellulose binder disappears in the reducing furnace without any resultant deterioration in the action of the bonding material and any binder for the powdered bonding material should be one that does not leave a deposit or harmfully impair the action of the bonding material. As has been stated preferably the entire surface of the container is treated to have thereon a thin film of the bonding material, as copper, which is alloyed with the material. The inner surface of the inner shell and the outer surface of the outer shell are preferably chromium plated after the bonding operation and the plated surfaces are thereafter polished to have high reflecting power so as to hinder the loss of heat from the contents of the container. In lieu of chromium plating any plating material can be used which is capable of receiving a high polish. Chromium plating is especially desirable in connection with the present container not only because of its resistance to tarnish and its properties as a reflector but also because it is well adapted for plating upon the copper alloy surface provided by the bonding process.

The open neck of the container is closed by a cork plug **100** or a plug of other material having low heat absorbing and conducting properties, which plug is seated upon the ledge **52** at the bottom of the neck **56** and is held with some pressure against the neck by a removable cap **102** which bears against the plug and is screw-threaded removably into the screw-threaded ring **86**. Said plug is provided with longitudinally extended passages or chambers **104**, see especially Figs. 2 and 7, which separately receive the handles **18** of the containers and thereby insulate the containers from the neck **56**.

While the container above described is particularly adapted for use in the distribution of individual portions of food at restaurants it can also be used for distributing food to homes, offices and the like, and in this case may be conveniently provided with a handle **106** so that it can be carried readily. When the container is used for restaurant service, however, the handle is not necessary.

For the storage and distribution of hot and cold liquids a modified form of container illustrated in Fig. 8 is convenient. The vacuum insulated container **108** is constructed essentially in the manner described above except that in this modification the neck **56***a* instead of being corrugated or screw-threaded throughout its length is plain. The stopper **110** comprises a cylindrical shell **112** having screw threads **114** at its upper end which engage with the screw threads of the ring **86** to secure the stopper in the container. The space within the shell **112** is occupied with an insulating body **116** as cork or the like and the stopper has secured thereto on its inner end a metal disc **118** that is seated on the ledge **52** and has a highly polished bottom face. A tube **120** composed of glass or other heat-insulating material is located axially within the stopper **110** and in the insulating body **116** and is open at its inner end to the interior of the container and at its outer end to a recess **122** in the top wall of the stopper, the recess being screw-threaded and normally closed by a removable screw-threaded plug **124**. The passage through the tube **120** is normally closed by a removable closure member comprising a stem **126** having an enlarged lower end or piston **128** that closely engages the inner face of the tube **120** and seals it against passage of liquid therethrough. The stem is provided at its upper end with an outstanding flange **130** that overlies the end of the tube and holds the piston **128** removably positioned in the lower end of the tube. The stem is provided at its upper end with a knob or handle grip **132** that is located in a chamber **134** of the plug **124**. This construction of closure member holds the piston **128** at the inner end of the stopper **110** and thus provides a long length of insulating stem **126** and glass tube **120** to oppose conduction of heat through the stopper. Liquids can be poured out of the tube by removing the plug **124** and the closure member. Access to the interior of the container for the removal or introduction of solid matter can be gained by unscrewing the stopper.

In accordance with this invention the evacuated containers as above described are loaded at the central kitchen with receptacles **20** containing individual portions of food. Each container for instance can receive three receptacles which contain different individual portions of food which make up an individual meal. If desired the food can be placed in the receptacles while hot but before it is completely cooked and allowed to finish its cooking in the receptacles within the evacuated containers. Each container with its loaded receptacles is sealed preferably shortly after it is loaded so that the customer by an inspection of the unbroken seal has assurance that the container has not been tampered with after loading. The seal, for instance, can comprise a label **136**, see especially Fig. 14, which is applied across the cap **102** or other closure member of the container and has its end affixed to the side wall thereof. The label preferably has an identification mark **138** which, when compared with a menu having the components of the various meals listed and identified by similar identification marks, gives the customer information as to the nature of the contents of the container. The seal is adapted to be broken by the customer before the closure can be removed and the food receptacles withdrawn. Preferably also the seal bears other data **140** such as the day and the time of loading of the container so that the customer can be assured that he is getting fresh food of proper temperature. The packed containers are received at the restaurants and are placed in individual compartments **142** or on shelves **144** of a display cabinet **146** located against a wall of the restaurant or in other positions convenient to access by the customer. Preferably the containers having the same character of meals are grouped together for convenience of the customers. Containers having meal #1, for instance, can occupy the top row of shelves, containers having meal #2 can occupy the next lower line of shelves, and so on. The customer is expected to select the meal he desires from a menu **145** displayed conveniently to the containers and ascertain therefrom the number of the meal and then remove from a compartment a container identified by the selected number and carry it to a table where he can remove and eat the contents.

It is also an object of this invention to provide such an arrangement that the customer must punch a check or ticket which identifies the meal during the act of removing the selected container from its compartment or prior to the complete removal thereof, which ticket the customer is expected to present to the cashier for payment. To this end each shelf **144**, see especially Figs. 9 through 13, is provided with a transverse front wall **146** which is located below the top face of the shelf and has a forwardly extended bracket plate **148** secured thereto. A compartment cover plate or barrier **150** is hinged to said bracket plate and is normally held in upright position over the open end of the compartment and against the wall of the next upper shelf by a coil spring **152**. The opposite long edge portions **154** of the cover plate are reflexed inwardly toward each other and over the body of the plate to provide opposed channels **156** in which a paper slip **158** constituting a check or ticket is removably received, the bottom edge of the check resting upon a lip **160** of the plate. The check preferably bears an identification mark **162**, as the number of the meal, contained in the container behind it, together with other data **164** indicative of the date and time packed. The check also bears a series of meal numbers **166**, the number corresponding to the number **162** of which must be punched out by the customer to indicate that he has actually withdrawn the container having the corresponding meal and has not substituted the check of a meal that might be cheaper in price. To effect the punching out of the meal number by the customer, the plate 150 is provided with a series of punch apertures 168 each of which is positioned in register with a separate meal number 166. The bracket plate 148 is provided with a plurality of screw-threaded punch holes 170 which are positioned in line with the punch aperture 168 and a punch member 172, see Figs. 9 and 10, can be screw-threaded into a hole 170, the position of which corresponds to the number of the meal contained in the associated container. The plate 150 is provided with a handle 174 which the customer can grasp to pull the plate down upon the bracket plate 148 to permit the withdrawal of the container and the act of positioning the plate 150 upon the bracket plate 148, which is necessary to effect the withdrawal of the container, automatically punches the check. The checks for the different meals preferably are differently colored, or are in some way differently distinguished, so as to indicate readily a check that has been substituted for one in a row of differently colored or identified checks, and thereby deter the substitution of a check for a cheap meal for one of a more expensive meal.

With the above described method and apparatus for vending foods it will be apparent that the food can be prepared at the central kitchen in the most appetizing manner and that the flavor of the food and its temperature will be retained during the distribution of the containers to the restaurants and the storage thereof in readiness for use so that the customer is assured of full flavored food that is served hot or at the proper temperature and has had the minimum of contact with contaminating influences. The dating and timing of the containers also is an assurance of freshness and proper temperature and if the customer is especially desirous of having hot foods he can select a container the time mark on which indicates that it was packed but shortly before his selection thereof. The amount of help required in a restaurant employing the present system can be reduced materially since no help is required in the dispensing of the meals. Increased cleanliness of the restaurants is also obtained.

In the claims, reference to a food container is intended to include a food container for foods the temperature of which is to be preserved, whether hot or cold.

I claim:

1. A heat-insulating food container having outer and inner spaced shells providing an evacuated heat-insulating space between them, the inner shell being rectangular in cross-section and having a long open neck that is circular in cross-section, a plurality of food-containing trays adapted to enter said inner shell through the circular neck thereof and be stored collectively thereon, said trays having handles that are located in and extend longitudinally of said neck, and a closure for the opening of said neck.

2. A heat-insulating food container having outer and inner spaced shells providing an evacuated heat-insulating space between them, the inner shell being rectangular in cross-section and having a long open neck that is circular in cross-section, a plurality of food-containing trays adapted to enter said inner shell through the circular neck thereof and be stored collectively thereon, said trays having handles that are located in and extend longitudinally of said neck, and a heat-insulating closure for said neck having individual chambers in which said handles are separately located.

3. A heat-insulating food container having outer and inner spaced shells providing an evacuated heat-insulating space between them, the inner shell having a long open neck, a plurality of food-containing trays adapted to enter said inner shell through said neck and be stored collectively therein and having a combined cross-section closely conformed with that of said inner shell, said trays having handles that are located in and extend longitudinally of said neck, and a closure for said neck.

4. A heat-insulating food container having longitudinal outer and inner spaced-apart shells providing a heat-insulating chamber between them, said inner shell being elongated and substantially rectangular in cross-section and having at one end a longitudinal neck the opening through which is substantially of the full width of the body of the inner shell, a set of two or more elongated food-containing trays having collectively a combined cross-section conforming generally to that of the container space and adapted to enter said inner shell longitudinally through such wide neck opening thereof and to be stored collectively in the container space within the rectangular body of said inner shell and each tray extending substantially the full length of such container space, but only a fraction of its width, said trays havng withdrawal means accessible through said neck for removing them from the container, and a closure for the opening of said neck.

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METHOD OF PRODUCING AEROGELS

Samuel S. Kistler, Urbana, Ill.

No Drawing. Application October 1, 1934,
Serial No. 746,412

23 Claims. (Cl. 252—6)

This invention relates to improvements in the art and process of producing dry gels from colloidal solutions, and the present specification is particularly directed to the production of a gel, one continuous phase of which is a gas, and which I therefore define as an aerogel.

Whenever a colloidal solution is precipitated, the product formed is usually defined as a gel. It is distinct from the precipitates from crystalloidal solutions by containing large quantities of the solvent in a soft "gelatinous" mass, usually microscopically heterogeneous and presenting some rigidity. Gels may be divided into two classes, the gelatinous precipitates and the jellies according to whether the product formed settles out in a flocculent mass or occupies the entire volume that the original solution occupied and appears microscopically homogeneous.

Gels may be again divided into elastic and non-elastic groups according to whether the gel will re-swell or not, after being dried, when placed in the original solvent. Examples of the elastic gel are gelatine and egg albumin, while examples of the non-elastic gel are silica and alumina gels.

The present invention applies to a new mode of removing the solvent from a gel, either elastic or non-elastic, in preparation for its use in the solid dried state, and the provision of a new class of products obtained thereby.

The most widely used of the inorganic gels in the dried condition for the purposes for which my product is most suited is that of silica, so that I shall describe something of its properties and mode of production, with explanation of the properties as they are now understood. I shall also list some of its commercial uses in order to indicate what may be the uses of my product.

Most of the gel now commonly used commercially is made by mixing rapidly a solution of water glass with a solution of some suitable salt or acid, usually the latter, and allowing the mixture to stand until it becomes a stiff jelly. The jelly is then broken up, washed free of salts and allowed to dry slowly. It shrinks greatly in drying and when completely dry it is a hard glassy mass. A great number of variations have been tried in the conditions of precipitation and drying but the properties of the final product can be affected only to a very limited extent. These materials are designated in the art as xerogels and are characterized and distinguishable from my products in that they can be wetted with the same liquid menstruum as employed in their preparation, and subsequently dried by simple volatilization of the liquid without changing the physical characteristics of the product materially. Thus ordinary silica gel (xerogel) can be immersed in water and subsequently dried at an elevated temperature and atmospheric pressure without changing materially its apparent density and other physical properties. On the other hand, an aerogel cannot be wetted and dried without loss of its characteristic properties. On the contrary when an aerogel is wetted and dried the drying operation results in shrinkage and other changes incident to its conversion to an xerogel.

The best theoretical treatment sets forth that the jelly is a mass of interlacing fibres. Upon removal of the liquid by drying, the surface of the liquid in trying to withdraw within the mass of submicroscopic fibres forms concave menisci, just as it forms in a small tube, and tends to draw the fibrils with it so that there is not only a shrinkage of the water, or solvent volume, but shrinkage of the entire mass. This pull of the liquid surface on the fibrils can easily be understood when it is remembered that the smaller a tube is the higher will water rise in it by capillarity. The spaces between the fibrils are the counterparts of exceedingly minute tubules.

It is therefore clear that the gel will shrink, until the fibrils are sufficiently compacted to withstand the compressive force due to the liquid surface. This force is very large, being of the order of thousands of pounds per square inch in easily imagined circumstances. With a substance as strong as silica, a point is reached where the shrinkage ceases and the water dries out, leaving a porous mass. Usually this mass contains from 30–50% voids by volume. In the extreme case that of a gel in which the drying was carried out with ferric oxide in the meshes and later the ferric oxide was dissolved out, a very fragile product was obtained having approximately 75% of its volume void.

The uses for silica gel in the dried condition depend upon the tendency of all molecules, either gaseous or in solution, to attach themselves to a surface. For a given volume of dried silica gel the internal surface is enormous so that easily condensed vapors show a very decided tendency to collect in the gel, and substances in solution can often be almost completely removed by the gel. In addition to the surface effect, there is the tendency for vapors to condense in fine capillaries much more readily than they condense in ordinary vessels.

These properties of the gel make it valuable for removing certain undesirable compounds from

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lubricating oils; for decolorizing sugar solutions during refining; for removal of vapors valuable or otherwise from gases such, for instance, as the removal of benzene from coke oven gas; and for drying of air, since the gel will remove water almost completely from air and can then be reactivated by simply heating and driving off the water. Its power to absorb vapors has made it serviceable in automatic refrigerator cars where it is used instead of water to absorb ammonia, and in gas masks it could easily prove valuable for removal of toxic gases.

Another important use of silica gel is as a carrier of contact catalysts. A contact catalyst is a substance that influences a chemical reaction at its surface without itself being consumed by the reaction. Since large surface is the principal requirement and since many contact catalysts are expensive, methods have been devised for coating the immense inner surface of silica gel with such catalysts, thus effecting considerable economies.

The primary object of the present invention therefore is to produce the gel by a method which will enable one at all times to have complete control thereof, whereby gels may be obtained with void space ranging all the way from the now usual 30–50% found in all commercial gels, up to 99% or higher. Another object of my invention is to provide a new class of gels—which are referred to herein as aerogels—and a method for their preparation, characterized in that they have inordinate adsorptive characteristics even as compared to the most porous active present day gels.

An additional object of my invention resides in producing a new class of colloidal products of an amorphous or essentially amorphous character, the degree of subdivision and spacial relationship of whose individual particles is the same as that in an undried gel or jelly or substantially of that order.

A further object is to produce the gels in an effective and economical manner.

The following examples illustrate embodiments of my invention:

Example 1.—I first form a hydrogel, such as silica hydrogel or jelly, in a suitable liquid medium, for example: water. For this purpose I may simply acidify water glass with sufuric acid in the well known manner employed in manufacturing silica gel of commerce. The gel is then washed free of soluble substances. In certain cases the gel may be, if desired, partially dried before washing in order to strengthen the mass to stand the washing action or to permit advantageous handling of the same. After being washed the gel is placed in a strong autoclave. The autoclave is nearly filled with a liquid and then closed. The liquid used may be either the water usually used in the precipitating operation or a substituted liquid more suited from a mechanical standpoint to carrying out my method as will be pointed out later. The whole mass in the autoclave is then slowly heated. Due to the expansion of the liquid with temperature, the gas space in the autoclave may be completely filled by the liquid considerably before the critical temperature is reached. In such a case continued heating would tend to cause further expansion of the liquid and thereby subject the vessel to excessive pressures. It therefore becomes necessary to release some of the liquid through a suitable valve. In practice the pressure is preferably maintained at or slightly above the critical pressure of the liquid. The minimum quantity of liquid that is advisable to use in the pressure vessel is that quantity which, when expanded to completely fill the vessel, will have the critical density. If the gel present contains this limiting quantity of liquid it is not necessary to add more.

Heating is continued (only enough liquid being released to prevent excessive pressures but not enough to produce substantial drying of the gel) until the temperature exceeds the critical temperature of the liquid in the pressure vessel. The gas is then released at a rate insufficient to damage the gel. The gel is left behind in a dried condition but having suffered little, if any, shrinkage.

If the gel is put into the vessel without added liquid, the liquid in the gel will expand with rising temperature more rapidly than evaporation into the closed space will occur, provided the total quantity of liquid present is equal to the minimum described above, and the gel will thereby not be subjected to compressive forces due to capillarity.

The principle upon which my method works is as follows:

Above the critical temperature no gas can be liquefied, regardless of how great the pressure. If the gel is covered with liquid in the autoclave, there will be no liquid-gas surface coinciding with the gel surface, and therefore there can be no compression of the gel structure due to capillarity. As the temperature rises the liquid is never allowed to evaporate down to where the gel is exposed. Now as the critical temperature is passed, the liquid is transformed into a gas imperceptibly so that whereas only a fraction of a degree below that temperature one could say that the gel is filled with liquid, when that temperature is exceeded by only the slightest amount one must say that the gel is now filled with gas. If the pressure is maintained above the critical point, no surface can form and the gel has no way of "knowing" when the liquid that it held in its meshes has been converted to a gas. Slow removal of the gas, slow only to prevent the disruption of the gel, leaves the gel in the expanded condition but dry, having at no time in the process experienced forces that would tend to compress it.

Since the surface tension of a liquid decreases as the temperature rises, becoming zero at the critical temperature, it would be possible to obtain gels in a partially shrunken condition by allowing the liquid to slowly evaporate at some temperature below the critical temperature. The nearer to that temperature that evaporation was allowed to occur, the smaller force would the gel have to withstand and consequently the less compression would it experience. The most practical method of controlling the density, however, seems to be to allow evaporation to proceed at ordinary temperatures under controlled conditions until the gel has shrunk as much as is desired, and then to place it in the autoclave and remove the remainder of the liquid as described above.

As previously stated, most gels are primarily formed in water, but water has an inconveniently high critical temperature and the critical pressure is very high, which would require very strong apparatus, if the water was continued as the liquid in carrying out the method here disclosed. Furthermore, water exerts a very powerful solvent action as the temperature rises so that some gels, for example that of silica, would dissolve before the critical temperature is reached. Silica is then precipitated as a very voluminous powder when the water is released above the critical temperature. This powder is of extremely fine texture and is valuable as a catalyst carrier in vanadium sulfuric acid catalysts. So far as I am aware this material has never been manufactured heretofore. However, in order to obtain the aerogels it is desirable and preferable, in my method, to substitute another liquid for the water. This is easily done by replacing the water in a gel with some liquid, such as an alcohol, that is very soluble or completely soluble in water. This liquid may then be replaced by other liquids miscible with it but insoluble in water.

In addition to the fact that my method enables one to obtain aerogels that could not have been prepared by known methods, it may be applied to partially shrunken gels. It therefore enables one to control completely the gel and obtain a product of just the desired density or porosity desired for a given purpose. The silica gel previously produced and which showed the maximum porosity so far obtained, possessed very little strength and has therefore not proved commercially practical. On the other hand, silica gel produced by my method and having the same apparent density, will have considerable strength and can be obtained in relatively large lumps or pieces which is not possible when made by present day methods.

As stated above, the only methods in existence prior to my invention for the control of the character of the final dried gel are crude in nature and ineffectual except over a limited range of properties. My invention enables complete control of the gel. The drying process may be stopped at any predetermined point and the liquid removed without further shrinkage of the gel skeleton. I have obtained silica gels with void space ranging all the way from the usual 30–50%, found in the present commercial gels, up to 99%, and I have certainly not reached the limit. If there were any reason for doing so, it is certain that I could obtain dry gels whose volume would be only 0.5% silica.

My improved method is applicable to all gels, and numerous gels that have never been produced in the dried condition with appreciable free space within them can now be obtained in as voluminous condition as desired. For example, aerogels of cellulose, collodion, gelatine, albumin, alumina, nickel hydroxide, thoria, titania, stannic oxide, magnesium hydroxide, chromic oxide are some of the other aerogels that I have prepared, and there is no reason to believe that the list cannot be extended almost indefinitely. The production of such gels as pyroxylin and cellulose in the distended condition offers a large field for investigation, and the probabilities are that such aerogels will prove valuable.

The aerogel seems to be particularly suited to the support of contact catalysts, especially for gaseous reactions, since gases can pass through the gels of low density with great facility and yet each molecule must come very close to a surface many, many times during the passage. Many of the catalysts can themselves be produced in the form of gels and thus do away with the necessity of supporting on silica to give them large surfaces.

In gas masks the voluminous gel may be used as an ultra-filter for the removal of submicroscopic particles from the air. Toward the end of the last war the masks were useless in combating certain extremely fine powders and fogs that were used to produce sneezing.

When a non-elastic aerogel of low density, such as that of silica, is powdered, the product is of extreme fineness and is useful as a polishing abrasive. The voluminous gel is a very excellent heat insulator.

Example 2.—Dissolve 44 grams of magnesium nitrate $Mg(NO_3)_2.6H_2O$ in a small amount of glycerin and make up to a volume of 50 cc. Thereafter add 35 cc. of diethyl amine diluted with glycerin to 100 cc. in a manner whereby the diethylamine solution floats on top of the magnesium nitrate solution. Now shake the two layers vigorously for a few seconds and allow the resulting mixture to set to a firm jelly. To remove the glycerin the jelly is extracted with alcohol until the glycerin is completely removed. The alcohol is then extracted by means of ethyl ether until most of the alcohol is removed. The resulting ether gel is then placed in a pressure vessel with excess ether, if necessary, and the temperature raised to 195° C. while maintaining the pressure sufficiently high to prevent evaporation of the ether. After the temperature has reached the critical point the vapor is permitted to escape. The resulting gel is very light, coherent, though fragile, elastic and transparent or translucent.

Example 3.—Dissolve 83 grams of chromic nitrate $Cr(NO_3)_3.9H_2O$ in 100 cc. of water to which there is then added, while stirring vigorously, 35 grams of ammonium acetate dissolved in 50 cc. of water. After the mixture is uniform it is permitted to set. A jelly will form in about 5 minutes. To remove the soluble salts the gel is broken up and washed with water, after which the water is replaced by alcohol and the alcohol is replaced, in part at least, by diethyl ether as described in Example 2. The ether-alcohol gel is then converted to the aerogel as described heretofore. The resulting product, when broken to pass a 10 mesh screen, has an apparent density of .25 gram per cc.

Example 4.—82 grams of stannic chloride $SnCl_4.5H_2O$ are dissolved in 200 grams of water and placed in a dialyzer, such as a sack made of regenerated cellulose as, for example, "Cellophane", and is then suspended in 2500 cc. of distilled water. After about 24 hours the contents of the sack will have set to a firm jelly. This jelly is then washed with methyl alcohol until most of the water has been removed, after which it is converted to an aerogel by heating to 260° C. before the vapors are released. The aerogel is very light, colorless and transparent.

Example 5.—53 grams of a commercial grade of dry thorium nitrate are dissolved in 35 cc. of methyl alcohol. The solution is allowed to stand a few hours before further use. 10 parts by volume of the aforementioned solution is then thoroughly mixed with 10 parts by volume of redistilled aniline. Subsequently 1.8–2.0 parts by volume of water are added whereby the water floats on top of the mixture. The resulting mixture is shaken vigorously for 1 to 2 seconds, and finally permitted to stand. After a very short period of time it will set into a jelly which is broken up and covered with a mixture of 9 volumes of methyl alcohol and one volume of concentrated aqueous ammonia. This mixture is changed from time to time over a period of several days until practically all of the aniline has been leached out. Finally, it is washed with pure methyl alcohol or acetone or a mixture of these two, and autoclaved to form thorium oxide aerogel.

Example 6.—380 grams of aluminum nitrate

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$Al(NO_3)_3.9H_2O$ are first dissolved in 1200 cc. of methyl alcohol, cooled to about −10° C. and stirred vigorously while adding 280 grams of redistilled aniline. The resulting mixture is allowed to attain room temperature at which time a firm jelly will have formed that can be extracted with methyl alcohol until free of aniline and salts. The alcohol-aluminum hydroxide jelly, or alcogel as it is referred to in the art, is then autoclaved to form an aerogel whereby an elastic, transparent product, having an apparent specific gravity of less than .1, which is relatively strong considering its low density, is obtained.

Example 7.—Sufficient gelatin is dissolved in hot ethyl alcohol containing sufficient acetic acid to form a firm jelly upon cooling. This jelly is then hardened by covering it with one of the higher alcohols, such as propyl or butyl, and allowing it to stand for several days. It is then extracted with ether to displace the alcohols. Alternatively, one may employ liquid propane or liquid dimethyl ether to displace, at least in part, the alcohol or alcohol-ether mixture. The resulting mixture is autoclaved at about 110° C. in the case of propane, or 130° C. in the case of dimethyl ether. Some shrinkage will be observed, but an aerogel having about 70% void space, which is strong, tough and transparent and through which gases diffuse readily, is obtained.

Example 8.—5 to 10 grams of agar-agar are dissolved in 100 cc. of water at its normal boiling temperature, and the solution is then allowed to cool to form a stiff jelly. The jelly is extracted with alcohol and then with ethyl ether, and finally with propane or dimethyl ether before autoclaving the same substantially as described in Example 7. The aerogel is a light, pithlike, opaque product.

Example 9.—A beaker is filled with a viscous collodion solution to a depth of 2 cm. Several centimeters of benzene are then carefully floated on top. After several days' standing the collodion has set to a clear, stiff jelly. The benzene containing gel is treated with liquid propane to displace the benzene, at least in part, and subsequently is converted to an aerogel which is light, strong and translucent.

In the foregoing description and examples a number of solvents have been disclosed and a number of media having more or less favorable critical temperatures have been enumerated. It will be understood that these are exemplary only and that in addition to alcohol (ethyl alcohol), methyl alcohol, acetone, dimethyl ketone, diethyl ether, dimethyl ether, benzene and propane, many other liquids may be employed. Similarly, many other combinations may be employed with the view of obtaining the aerogel forming phenomenon under the most favorable temperature and pressure conditions.

Reference is herein made to the Miller and Connolly Patent #1,772,055, wherein a silica hydrogel is heated in the presence of liquid water for the purpose of effecting a hardening of the gel. However, in this process the final removal of water is effected by the more or less conventional means and the shrinking phenomenon occasioned by the high surface tension of liquid water manifests itself. Accordingly, one obtains by this procedure a product which has an apparent specific gravity of as low as .5 but does not have the properties of aerogels. The Miller and Connolly product may be treated with water and dried, repeatedly, to obtain a somewhat similar product each time whereas my aerogel, when treated with water and subsequently dried, is converted to the xerogel having a substantially higher apparent specific gravity, otherwise lacking the characteristics of the aerogel and rather simulating the Miller and Connolly product so far as specific gravity is concerned. For example, if a silica aerogel with a specific gravity of .1 is wetted with water and subsequently dried, the resulting dried product resembles Miller's product and has a specific gravity of approximately .6. I have not been able to produce an aerogel from a gel not previously dried that will not shrink in this manner when wetted and subsequently dried in the conventional manner.

Finally, it is to be noted that the Miller and Connolly process is not capable of producing a product having the low apparent specific gravities which I am able to obtain since the limiting factor of the surface tension of the water is not overcome by Miller and Connolly. Consequently, shrinking, which attends the removal of water by conventional means, manifests itself. In general, and in the absence of purposeful preliminary shrinkage, my aerogel products are characterized in part by the fact that their apparent specific gravity is not substantially greater than 15% of the actual specific gravity of the substance.

The aerogels are distinguishable from ordinary xerogels by their inordinate catalytic activity. For example, in the vapor phase oxidation of acetaldehyde to acetic acid, a silica aerogel performs more satisfactorily than the ordinary silica gel due in part to the fact that the aerogel does not become fouled as rapidly. In comparative tests the aerogel did not show any signs of fouling during the course of the runs while the ordinary gel turned yellow and showed resinous materials deposited thereon. Thoria aerogels convert carboxylic acids, as for example acetic acid, to ketones with practically quantitative yields at 300° C., while the best form of thoria that was obtained by heating the oxalate required a reaction temperature of at least 50° higher, the conversion was incomplete and side reactions resulted in the formation of by-products. It is to to be understood that for certain catalytic purposes it is desirable to have a mixed aerogel, that is, an aerogel containing more than one metallic component. These may be produced, preferably, by mixing the alcogels or ether gels before the autoclaving operation. The following example illustrates an alternative procedure for preparing one such mixed gel:

Example 10.—A silica hydrogel was soaked in a strong solution of aluminum sulphate for 24 hours, after which it was dropped into a concentrated ammonia solution. The resulting gel was washed with water to remove soluble salts, extracted with alcohol and autoclaved in the usual manner. This gel was found to be more active in the oxidation of acetaldehyde to acetic acid than either a silica aerogel or an alumina aerogel.

In addition to the foregoing distinguishing characteristics of the aerogels, their thermal conductivity further emphasizes the fundamental difference between aerogels as a class and xerogels or products such as Miller and Connolly describe. To illustrate: silica aerogel, having an apparent specific gravity of .18, shows a heat conductivity lower than any solid which has ever been measured so far as I have been able to ascertain. Its heat conductivity at 34° C. is 4.85×10^{-5} cal./sec./°C./cm. This constant compares very favorably with some of the best known heat insulators of which the following are representative:

Cork	10×10^{-5}
Asbestos	22×10^{-5}
Best grade of mineral wool	7.6×10^{-5}
Loose cellulose fibres	8.4×10^{-5}

One of the advantages of the silica aerogel resides in its ability to withstand elevated temperatures of at least 800° C. indefinitely while other aerogels, such as alumina aerogels, will stand even higher temperatures. Ordinary silica gels (xerogels) are not much better than ordinary sand and possess no usefulness in the field of heat insulation.

Another feature of the aerogel products of the inorganic type resides in the fact that they do not pack or settle. It is well known that many finely divided materials tend to pack, leaving void spaces, and for this reason are not entirely satisfactory heat insulating media. Aerogels, on the other hand, show little or no such tendency. Moreover, while the materials are fragile, nevertheless they will support considerable weight, particularly when supported and in this respect are distinctly superior to materials such as mineral wool and asbestos which lose their valuable heat insulating properties as they are compressed or as they may settle. In other words, it is absolutely necessary, in order to preserve the heat insulating value of these materials, to preserve their fluffy nature.

Due to the porous nature of the aerogel much of the heat that is transferred passes through the gas phase. Accordingly, by substituting a gas of low thermal conductivity for air it is possible to improve the thermal resistance of the aerogels appreciably. For example, a gel that has a conductivity of 4.85 with air, has a conductivity of 4.33 when saturated with carbon dioxide and 3.71 when filled with dichlorodifluoromethane. Where the material is to serve as an insulator for refrigerator units and the like it is possible to lodge the insulator within a metal case which can be evacuated, the residual gas present being preferably one of low heat conductivity.

From the foregoing description it will be evident that I have provided a new class of products, aerogels, and various methods for their preparation. It will likewise be apparent that the aerogels are characterized by the fact that they are formed from colloidal gels in which the liquid menstruum is removed, at least in part, by heating the liquid under pressure beyond its critical temperature, and subsequently releasing the liquid thus heated. In this manner it is possible to produce a skeleton of the solid component of the gel as it actually exists before treatment and differing only in that the liquid medium is displaced by a vapor or gas. I have also shown that it is possible to produce materials in voluminous precipitated form by heating a solution thereof to or beyond the critical temperature, and releasing the sol in its gaseous state. The invention affords a novel class of materials having unique properties which render them of special importance in the field of catalysis, thermal insulation, or a variety of other uses where a high degree of porosity or fineness of subdivision is of importance.

The present is a continuation-in-part of my copending application Serial Number 508,811, filed by me on January 14, 1931.

Attention is drawn to applications covering unclaimed subject matter disclosed in this specification, including specifically application Serial Number 135,801, filed April 8, 1937.

Attention is also called to my co-pending applications, Serial Numbers 151,969, 151,970 and 151,971, filed July 3, 1937.

What I claim is:

1. That method of producing a dry aerogel comprising the steps of precipitating a colloidal substance in a liquid as a gel, confining the resulting product in a pressure vessel, applying heat thereto until the liquid in the gel has reached a temperature at which the surface tension of the liquid is so small as to produce no substantial shrinkage of the gel when the liquid is allowed to evaporate, maintaining such temperature, and then releasing the vapor from the pressure vessel at a rate insufficient to injure the gel.

2. That method of producing a dry aerogel comprising the steps of first precipitating a colloidal substance in a liquid as a gel, substituting for the first liquid a second liquid having less solvent action and a lower critical temperature, confining the resulting product in a pressure vessel, applying heat thereto until the liquid in the gel has reached a temperature at which the surface tension of the liquid is materially reduced whereby to reduce the ultimate shrinkage of the gel when the liquid is allowed to evaporate, maintaining such temperature, and then releasing the vapor from the pressure vessel at a rate insufficient to injure the gel.

3. That method of producing a dry aerogel comprising the steps of precipitating a colloidal substance in a liquid as a gel, partially drying the same to a volume greater than the volume of the completely dried product, confining the partially dried product in an autoclave, applying heat thereto until the liquid in the gel has reached a temperature at which the surface tension of the liquid is so small as to produce no substantial shrinkage of the gel when the liquid is allowed to evaporate, maintaining the temperature and then releasing the vapor from the autoclave at a rate insufficient to injure the gel.

4. That method of producing a dry aerogel comprising the steps of precipitating a colloidal substance in a liquid as a gel, confining the resulting product in a pressure vessel in an amount insufficient to entirely fill the autoclave, applying heat to the product to expand and place the liquid therein under pressure within the pressure vessel, then continuing to apply heat thereto until the liquid in the gel has reached a temperature at which the surface tension of the liquid is so small as to produce no substantial shrinkage of the gel when the liquid is allowed to evaporate, maintaining such temperature, and then releasing the vapor from the pressure vessel at a rate insufficient to injure the gel.

5. That method of producing a dry aerogel comprising the steps of first precipitating a colloidal substance in a liquid as a gel, substituting for the first liquid a second liquid having less solvent action, confining the resulting product in a closed pressure vessel, applying heat thereto until the liquid in the gel has reached a temperature at which the surface tension of the liquid is materially reduced whereby to reduce the ultimate shrinkage of the gel when the liquid is allowed to evaporate, maintaining such temperature, and then releasing the vapor from

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the pressure vessel at a rate insufficient to injure the gel.

6. That method of producing a dry aerogel comprising the steps of first precipitating a colloidal substance in a liquid as a gel, substituting for the first liquid a second liquid having a lower critical temperature, confining the resulting product in a pressure vessel, applying heat thereto until the liquid in the gel has reached a temperature at which the surface tension of the liquid is materially reduced whereby to reduce the ultimate shrinkage of the gel when the liquid is allowed to evaporate, maintaining such temperature, and then releasing the vapor from the pressure vessel at a rate insufficient to injure the gel.

7. The method of producing a dry aerogel characterized in that a gel consisting of a colloidal solid dispersed in a liquid menstruum is formed, after which the liquid is removed without causing substantial shrinkage of the gel, characterized in that the liquid is heated beyond its critical temperature in an autoclave without substantial release of vapor and is then subsequently vented without causing substantial condensation.

8. The method as defined in claim 7 and further characterized in that the liquid in which the gel is formed is displaced by a liquid having a lower critical temperature before the heating step.

9. A gel having an apparent specific gravity of not substantially in excess of 15% of the true specific gravity and further characterized in that it is relatively free of liquids and consists essentially of the porous skeleton of the colloid substantially as it existed in the original undried gel.

10. An aerogel consisting of a refractory substance, said aerogel having an apparent density of not substantially more than 15% of the actual density, and further characterized in that the gas present is of a lower thermal conductivity than air.

11. A method of treating gels containing substantial amounts of liquids of low solvent capacity for the gel substance dispersed therein which comprises heating the gel in an autoclave without substantial release of vapor to a temperature above the critical value for the liquid and then subsequently gradually venting the resultant vapors without condensation to obtain a porous structure.

12. A porous, substantially liquid-free gel having the cavities thereof filled with a gas, the volume of a unit of the gel being substantially that of the same unit when it is initially formed and still has the cavities thereof filled with liquid prior to drying, the gel being further characterized by the fact that when it is re-wet with a liquid and that liquid is evaporated at pressures substantially below critical that material volume shrinkage by the gel structure occurs.

13. An inorganic gel having an apparent specific gravity not substantially in excess of 15% of the true specific gravity and further characterized in that it is substantially free of liquids and consists essentially of the skeleton of the colloid substantially as it existed in the original undried gel.

14. A silica gel having an apparent specific gravity not substantially in excess of 15% of the true specific gravity and further characterized in that it is substantially free of liquids and consists essentially of the skeleton of the colloid substantially as it existed in the original undried gel.

15. A gel having an apparent specific gravity of not substantially in excess of 15% of the true specific gravity and further characterized in that it is substantially free of liquids and consists essentially of the skeleton of the colloid substantially as it existed in the original undried gel.

16. A titanium oxide gel having an apparent specific gravity not substantially in excess of 15% of the true specific gravity and further characterized in that it is substantially free of liquids and consists essentially of the skeleton of the colloid substantially as it existed in the original undried gel.

17. A thoria gel having an apparent specific gravity not substantially in excess of 15% of the true specific gravity and further characterized in that it is substantially free of liquids and consists essentially of the skeleton of the colloid substantially as it existed in the original undried gel.

18. A gel having an apparent specific gravity not substantially in excess of 15% of the true specific gravity and further characterized in that it is substantially free of liquids and consists essentially of the skeleton of the colloid substantially as it existed in the original undried gel, the gel being further characterized by a high thermal insulating power.

19. An inorganic refractory gel having an apparent specific gravity not substantially in excess of 15% of the true specific gravity and further characterized in that it is substantially free of liquids and consists essentially of the skeleton of the colloid substantially as it existed in the original undried gel, the gel being further characterized by a high thermal insulating power.

20. A substantially liquid-free gel, the volume of a unit of the gel being substantially that of the same unit before the liquid menstruum from which it was formed was substantially completely removed therefrom, the liquid-free gel being further characterized by the fact that when it is re-wet with a liquid, and that liquid is evaporated under conditions of temperature and pressure such that a substantial surface tension of the liquid is maintained during the evaporation, the volume of the gel structure undergoes substantial shrinkage.

21. A substantially liquid-free inorganic gel, the volume of a unit of the gel being substantially that of the same unit before the liquid menstruum from which it was formed was substantially completely removed therefrom, the liquid-free gel being further characterized by the fact that when it is re-wet with a liquid, and that liquid is evaporated at pressures substantially below the critical pressure, the volume of the gel structure undergoes substantial shrinkage.

22. A substantially liquid-free inorganic refractory gel, the volume of a unit of the gel being substantially that of the same unit before the liquid menstruum from which it was formed was substantially completely removed therefrom, the liquid-free gel being further characterized by the fact that when it is re-wet with a liquid, and that liquid is evaporated under conditions of temperature and pressure such that a substantial surface tension of the liquid is maintained during the evaporation, the volume of the gel structure undergoes substantial shrinkage, the gel being further characterized by a high thermal insulating power.

23. A substantially liquid-free gel of a compound containing in chemically combined form

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an element of group four of the periodic system of classification of the elements, the volume of a unit of the gel being substantially that of the same unit before the liquid menstruum from which it was formed was substantially completely removed therefrom, the liquid-free gel being further characterized by the fact that when it is rewet with a liquid, and that liquid is evaporated under conditions of temperature and pressure such that a substantial surface tension of the liquid is maintained during the evaporation, the volume of the gel structure undergoes substantial shrinkage.

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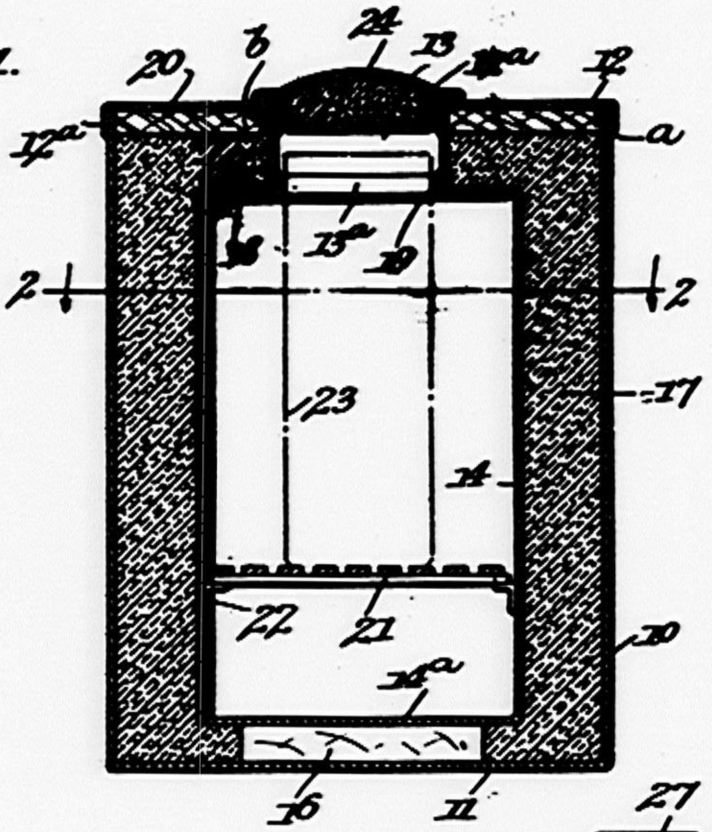
Fig.1.



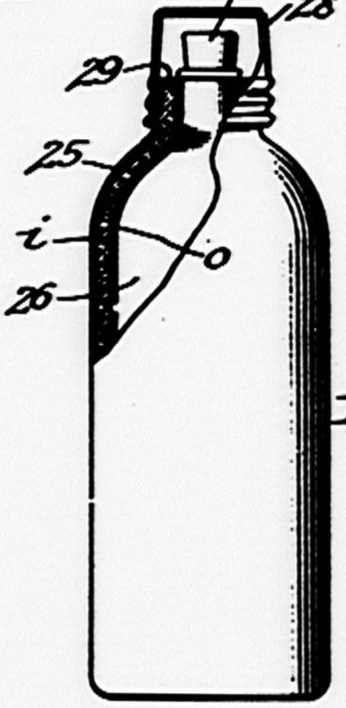


Fig.3.

Fig.2.

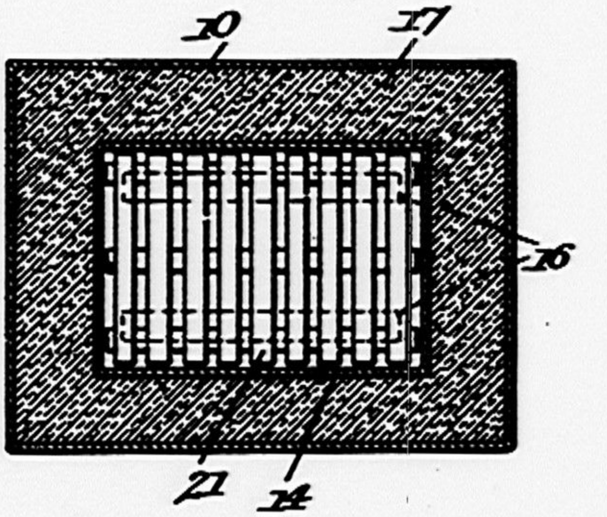


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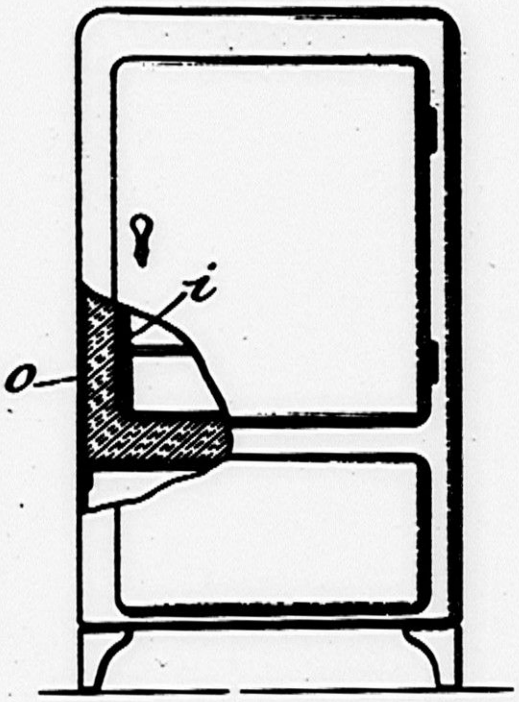
Fig. 4.



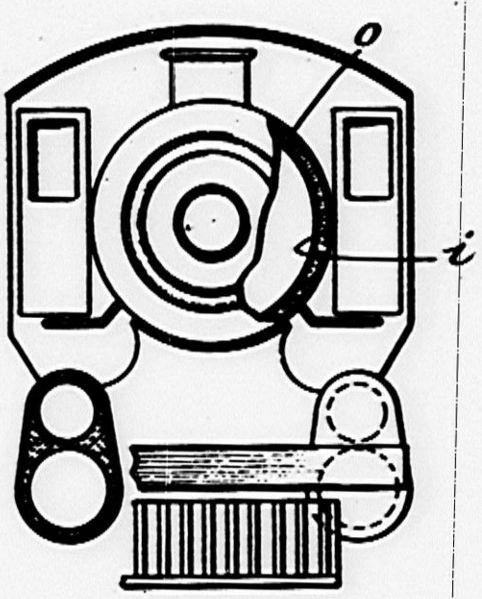
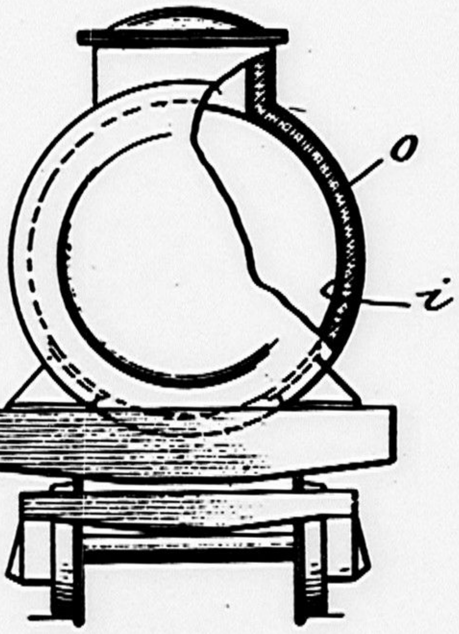


Fig. 6.

Fig. 5.



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Department of Commerce
U. S. Patent Office
Washington

On Appeal Before the Board of Appeals

In re application of Samuel S. Kistler,
Serial No. 135,801, Filed April 8, 1937,
For: Thermally Insulated Structures and
Method of Making Same

Examiner's Statement

This is an appeal from the action of the Primary Examiner in finally rejecting claims 1 to 9, inclusive, 13 and 14. Claims 10, 11 and 12, the only other claims in the case, are directed to none-elected species and have been rejected on the grounds of estoppel subject to the allowance of generic claims. Applicant has taken no issue with the rejection of claims 10, 11 and 12, merely retaining them in the application.

The finally rejected claims are:

Claim 1—A thermally insulated structure comprising, at least, two spaced walls having an inorganic aerogel disposed in the space therebetween as a thermal insulator.

Claim 2—In an insulated structure having heated material in the interior thereof, said insulated structure comprising spaced walls surrounding the heated material, at least in part, the space between said walls being filled with an inorganic aerogel in intimate contact with the surfaces of said walls.

Claim 3—In an insulated structure having cooled material in the interior thereof, said insulated structure comprising spaced walls surrounding the cooled material, at least in part, the space between said walls being filled with aerogel in intimate contact with the surfaces of said walls.

246 Claim 4—An insulated structure comprising, at least, two spaced walls having an inorganic aerogel disposed in the space therebetween and in contact with said walls, the inorganic aerogel being in sufficiently fine state of sub-division to give it flowing properties whereby it may be poured into the space between the walls.

Claim 5—An insulated structure comprising, at least, two spaced walls having silica aerogel disposed in the space therebetween and in contact with said walls, said aerogel being in sufficiently fine state of sub-division to occupy substantially all of the space between the walls.

Claim 6—The method of thermally insulating structures which includes the steps of providing an enclosed space substantially surrounding the structure and filling the space with silica aerogel in a sufficiently fine state of subdivision to flow into said space.

Claim 7—The method of thermally insulating structures which includes the steps of providing an enclosed space substantially surrounding the structure, filling the space with silica aerogel in a sufficiently fine state of sub-division to flow into said space, and sealing said space.

Claim 8—The method of thermally insulating structures which include the steps of providing an enclosed space substantially surrounding the structure, filling the space with silica aerogel, evactuating said space and then hermetically sealing the same.

Claim 9—A thermally insulating container comprising inner and outer shells of similar shape, the inner shell being of less dimension than the outer shell and supported out of contact with the walls of the outer shell, aligned openings in said shells, a wall of insulating material extending between the edge portions of said openings, silica aerogel disposed in and filling the space between said inner and outer shells, a shelf disposed in the inner shell and supported between the upper and lower ends thereof, the space below the shelf being adapted to contain a refrigerant and the space above the shelf being adapted to support the substances to be kept cooled, and a cover for said openings.

247 Claim 13—A thermally insulated structure comprising at least two spaced walls having pulverized, substantially incompressible, free-flowing silica aerogel disposed therebetween as a thermal insulator and substantially filling the space between said walls and means for preventing the leakage of a substantial portion of the free-flowing aerogel from between said walls under normal conditions of handling and use.

Claim 14—A thermally insulated structure comprising at least two spaced walls having pulverized, substantially incompressible, free-flowing silica aerogel disposed therebetween as a thermal insulator and substantially filling the space between said walls and forming a support therefor, and means for preventing the leakage of a substantial portion of the free-flowing aerogel from between said walls when the latter are compressed toward each other by an exterior force.

The references relied upon are:

Stanley	1,071,817
Schellens	2,038,763
Kistler	2,093,454

The alleged invention relates generally to thermally insulated, spaced wall structures.

Applicant has illustrated in the drawings, more or less diagrammatically, several spaced wall structures which utilize as an insulating medium a material known as aerogel which material is described in detail and claimed in applicant's copending application, Serial No. 746,412, which has now matured into patent No. 2,093,454. The various forms of construction illustrated are apparently supposed to be conventional structures and the novelty is in the use of aerogel or the insulating material between the spaced apart walls of said structures. The method of applying the insulating material to the spaced wall receptacles is in general the same in all the forms illustrated and so will be described only in relation to the first form which is shown in Figs. 1 and 2.

248 In Fig. 1 and 2 there is shown a typical ice cream storage container comprising an outer wall or shell 10 and an inner shell 14 spaced from said outer shell to provide a space for insulating material 17. The insulating material, which is aerogel in either granular or powdered form, preferably the latter, is poured into the space between the inner and outer shells through the top of the outer container before the latter is closed.

In the form shown in Fig. 3 the applicant states that the insulating space between the walls i and o may be evacuated after introducing the aerogel and before sealing the space.

The patent to Stanley shows a heat insulated container comprising inner and outer shells 1 and 4 and a finely powdered insulating material 20 filling the space between said shells. After the insulating material 20 has been introduced the space between the shells is evacuated through tube 15 and then the space is sealed.

The patent to Schellens shows in Figs. 2 and 3 an insulated space wall container comprising inner and outer spaced shells 38 and 62, respectively, and loose insulating material 80 packed tightly in the space between the shells. After the insulation is placed in the space, the space is evacuated through opening 72 which is subsequently sealed.

The Kistler patent 2,093,454 which matured from applicant's coopending application 746,412 describes inorganic aerogel as being an excellent heat insulator. See
249 lines 9 to 43, inclusive, column 1, page 5 of Kistler.

Claims 9, 10 and 12 to 23, inclusive, of the Kistler patent are directed to the material aerogel per se and claims 10, 18, 19 and 22 include the limitation that the aerogel is "characterized by a high thermal insulating power".

Claims 1 to 9, 13 and 14 have been rejected on the ground that they are drawn to an old combination of spaced walls or spaced shells and a pulverized loose insulating material between said walls as shown by either Schellens or Stanley. There is no new combination or coaction between applicant's various elements not shown by either of the references.

Claims 1 to 9, inclusive, 13 and 14 have been further rejected as unpatentable over either Schellens or Stanley in view of the claims of Kistler 2,093,454. It has been held that to substitute the aerogel insulating material claimed in the Kistler patent for the powdered insulation of Schellens or Stanley would amount to no more than an obvious substitution of materials which would produce no new or unobvious result or advantage. Admitting that aerogel is a better insulating material than that used by the references it is a well established rule that to substitute a superior material for an inferior material in an old combination does not involve invention unless the new material causes a new or unobvious result in said combination.

250 Claims 1 to 9, 13 and 14 have been further rejected as unpatentable over the claims of Kistler, specifically claims 10, 18 and 19. The claims of this application merely cover an obvious use of the aerogel claimed in patent 2,093,454. It has been considered that to employ the patented material, aerogel, which has known and claimed insulating properties, in a conventional spaced wall structure such as shown by Schellens or Stanley is merely puting the material to the use for which it is intended. In re Byck, 1931 C. D. 391 and Underwood v. Gerber, 1893 C. D. 40 were cited in support of the last rejection.

It is thought that the claims were properly rejected.

E. J. DRUMMOND,
Examiner, Div. 40.

251 Endorsed: U. S. Patent Office Board of Appeals
Mailed Jun 17 1941

Paper No. 27

Appeal No. 36,184 RHJ

In the United States Patent Office

Before the Board of Appeals

Ex parte Samuel S. Kistler

Application for Patent filed April 8, 1937, Serial No. 135,801. Thermally Insulated Structures and Method of Making Same.

Mr. Joseph R. Mares and Mr. J. Russell Wilson for appellant.

This is an appeal from the action of the Primary Examiner finally rejecting claims 1 to 9, 13 and 14.

Claim 1 will serve as illustrative:

1. A thermally insulated structure comprising, at least, two spaced walls having an inorganic aerogel disposed in the space therebetween as a thermal insulator.

The references relied upon by the examiner are:

Stanley, 1,071,817, Sep. 2, 1913,
Schellens, 2,038,763, Apr. 28, 1936,
Kistler, 2,093,454, Sep. 21, 1937.

The claims on appeal are directed to an insulated structure which comprises a confined mass of a specific insulating material, which is referred to as "an inorganic aerogel." The general arrangement of the organization claimed
is one which is common in the prior art and shown,
252 for instance, in the Stanley patent. The particular
material used for insulating purposes appears to
have originated with appellant and he has been granted patent No. 2,093,454 on this specific material.

In the patent, various utilities for the material are disclosed, including high thermal insulating power. This particular utility is stressed in the claims of the patent. Under the circumstances, it is the examiner's view that appellant is not entitled to another patent which involves no more than the application of the patented material to a disclosed use in an organization which is otherwise conventional in the art.

In making this rejection, the examiner relies on a number of decisions, including In re Byck, 1931 C. D. 391. It seems to us that the present facts are quite similar to those involved in the Byck case. It was recognized in the Byck case that there are instances where a patentee of a product may be entitled to further patents for uses of the product which are unobvious. It was pointed out, however, that Byck could not have received a patent unless he disclosed utility for the product and that disclosure of such utility did not constitute a separate invention but was an essential part of a single invention. The same reasoning appears to be applicable here. If applicant were to be given added protection for the use of his material in an insulating organization, he might also, with equal justice, be given other patents directed to the other uses disclosed in his patent, whereupon, upon the expiration of the original patent, no one would be able to use the material covered
253 thereby. This seems to lead to an absurd situation.

We have given careful consideration to the appellant's various contentions but are unable to see wherein the examiner erred in rejecting the claims.

The examiner's action is therefore affirmed.

Board of Appeals

EUGENE LANDERS
Examiner-in-Chief
B. PIERCE
Examiner-in-Chief
F. J. PORTER
Examiner-in-Chief

Mr. J. R. Wilson
1700 S. Second St.
St. Louis, Mo.
June 17, 1941

UNITED STATES
COURT OF APPEALS FOR THE
DISTRICT OF COLUMBIA

FILED SEP 15 1943

Joseph W. Stewart

CLERK

BRIEF FOR APPELLEE

In the United States Court of Appeals for the District of Columbia

Appeal No. 8517

SAMUEL S. KISTLER, APPELLANT
v.
CONWAY P. COE, COMMISSIONER OF PATENTS, APPELLEE

APPEAL FROM THE JUDGMENT OF THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLUMBIA

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In the United States Court of Appeals for the District of Columbia

Appeal No. 8517

Samuel S. Kistler, appellant
v.
Conway P. Coe, Commissioner of Patents, appellee

APPEAL FROM THE JUDGMENT OF THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLUMBIA

BRIEF FOR THE COMMISSIONER OF PATENTS

INTRODUCTION

This is an appeal from the judgment (9)[1] of the District Court of the United States for the District of Columbia, dismissing the complaint (2) brought by appellant, Samuel S. Kistler, to obtain the issuance of a patent on his application, No. 135,801, for THERMALLY INSULATED STRUCTURES AND METHODS OF MAKING SAME (50), filed April 8, 1937.

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[1] The numbers in parentheses throughout this brief refer to pages of appellant's appendix.

STATEMENT

The application relates to thermally insulated structures and a method of making such structures and particularly to using as the thermal insulator, a material known as "aerogel." This material was originated by applicant and he was granted a patent therefor (78), being patent No. 2,093,454, issued September 21, 1937, on an application filed October 1, 1934. This "aerogel" and the method of making it are fully described in this patent which contains claims for the article and claims for the method.

The claims here in suit are for the article in which the "aerogel" is used as the insulating material and for the process of making it. This process, in substance, is merely putting the "aerogel" between the walls of the structure.

The rejection of the claims by the examiner was based on the ground that applicant, having been granted a patent on the article and one of its characteristics thereof being stated as a high insulating value and it being old to make thermally insulated structures using other types of insulating material, it was not a further invention to use his patented material for that purpose.

As showing such structures the examiner cited the patent to Stanley, No. 1,071,817 (65) which shows a heat insulated container comprising inner and outer shells with finely powdered insulating material therebetween and the patent to Schellens, No. 2,038,763,

(70) which discloses a container having inner and outer walls with loose insulating material therebetween, the space between the walls being evacuated after the filling is placed in the space and then sealed.

The Stanley patent (67, page 2, column 2, line 2) suggests sublimed silica as a good insulating substance to use, and the Schellens patent suggests (75, page 2, column 1, lines 22–26) a loose heat insulating material such as loose asbestos fibres.

The Board of Appeals affirmed the rejection on the same ground, citing the decision of the Court of Customs and Patent Appeals in *In re Byck,* 18 C. C. P. A. 1208, 48 F. (2d) 665, 1931 C. D. 391.

The District Court made the following findings:

> 5. The Kistler patent, No. 2,093,454, discloses a process for making a dry aerogel and the material itself, which is referred to as a silica aerogel. This patent describes the material as having a high thermal insulating power, and claims 18 and 19 of the patent specify as a quality of the gel claimed that it is characterized by high thermal insulating power.
>
> 6. It was not further invention for the applicant to use the material of his patent as an insulating material for thermally insulated structures.

THE APPEALED CLAIMS

Claims 1, 2, 3, 4, 5, 9, 13, and 14 are for the article—a thermally insulated structure—and claims 6, 7, and 8 are for a method of thermally insulating structures.

Claims 1 and 6, which are respectively illustrative of these two groups, read as follows:

> 1. A thermally insulated structure comprising, at least, two spaced walls having an inorganic aerogel disposed in the space there between as a thermal insulator.
>
> 6. The method of thermally insulating structures which includes the steps of providing an enclosed space substantially surrounding the structure and filling the space with silica aerogel in a sufficiently fine state of subdivision to flow into said space.

SUMMARY OF ARGUMENT

Only one patent may be granted on a single invention.

Applicant having been granted a patent on the article he invented, to wit, the "aerogel," which has a high insulating value, it was not a further invention to use it in lieu of other insulating materials in forming insulated structures. To grant such a patent would be an extension of the monopoly of his patent No. 2,093,454.

ARGUMENT

Ever since the decision of the Supreme Court in 1894 in *Miller* v. *Eagle Mfg. Co.,* 151 U. S. 186, 1894 C. D. 147, it has been settled law that a single invention will support but a single patent.

In its decision in *In re Rowe,* 40 App. D. C. 423, 1913 C. D. 426, this Court said:

> Where the one invention is disclosed, but one patent can issue.

And then applying that statement to the case before it said:

> Agreeing as we do in the conclusions of the Office tribunals that there is but one invention disclosed in the patent and the application, we regard it as unnecessary to discuss the question further.

The above holding was approved by this Court in *In re Taylor,* 52 App. D. C. 249, 285 F. R. 983, 1923 C. D. 252.

The reason for that ruling is found in the Patent Statutes themselves. Sec. 4886 R. S. (U. S. C. Title 35, Sec. 31) provides that any person who has "invented or discovered any new and useful art, machine, or composition of matter" may, under certain conditions "obtain a patent therefor." That is as far as the Patent Office may go and neither directly or indirectly is the issuance of a second patent for the same invention to the same inventor, authorized.

Section 4884 R. S. (U. S. C. Title 35, Sec. 40) provides that the term of a patent shall be 17 years. At the end of that term the monopoly granted by the patent ceases. But to issue another patent for the same invention would extend that monopoly for a further term.

Applicant's patent discloses the article and the process of making it in detail. It sets out various uses to which the article may be put including its use as a heat insulator (80, column 1, line 60 to column 2, line 4).

Would it not be obvious, from the statements in the patent, that the claimed product could be substituted for other known heat-insulating materials? It would seem to be so obvious that "a wayfaring man though a fool could not err" in that respect.

Certainly, it being obvious that the article could be thus substituted, it involved no invention to do so.

Whether there might be a further invention, if some other use was discovered for the article which was not mentioned in the patent and was not obvious from the prior art, is not a question here involved; and the determination of that question would have no bearing on the question which is here involved.

Appellant in his brief has stressed the fact (Brief, page 14) that Kistler did not undertake his line of studies for the purpose of making inventions, but was concerned primarily with "acquiring more knowledge about the universe we live in."

However, if that might have some bearing on the validity of the claims of the patent, it could have no bearing on the patentability of the appealed claims. That question has nothing to do with the issuance of the prior patent but is only whether a second patent, based on the same invention, should be issued. Again the brief stresses the unexpected results that were obtained as a result of Mr. Kistler's work and the remarkable properties of the "aerogel," as an insulating material and otherwise, but while these may give great support to the issued patent, they have no bearing whatever on the question of the patentability of the claims of the application here in suit.

The brief cites no decision which supports the argument of appellant as to the patentability of the present claim.

The quotation from *In re Germantown Trust Co.,* 19 C. C. P. A. 1140, 57 F. (2d) 365, is only to the effect that, in considering the question of double patenting, we are restricted to a consideration of the claims of the first patent. That is exactly what has been done here.

The next cited decision is to the same effect. The citation from *General Bakelite Co.* v. *General Insulate Co.,* 276 F. R. 166 is only a generalization as to conditions under which several patents might be issued to an inventor. There is nothing in the quoted matter to indicate that it has any bearing on the present case nor does a reading of the entire decision indicate that it has.

A careful reading of the decisions of this Court does not disclose that it had had before it a case just like the present, i. e., a case involving a patent on an article and an application for a patent based on the use of the article. The theory of the above cited decisions of this Court are, however, it is submitted, clearly applicable to the present case.

The decision of the Court of Customs and Patent Appeals in *In re Byck,* 18 C. C. P. A. 1208, 48 Fed. 665, 1931 C. D. 391, is on all fours with the present case.

There the court had before it the question whether a claim for an article of manufacture consisting of a flexible electric conductor having an adhering insulating coating of an infusible, flexible, phenol-fatty oil composition should be allowed when applicant had already obtained a patent on the phenolic condensation product with which the conductor was coated.

In its decision the Court said:

> It is elementary that there can not be more than one valid patent for the same invention

and then said:

> We think it clear that the application here in issue does not claim a separate invention from that claimed in the issued patent, but only claims an obvious use of the composition there patented. If appellant's position is well taken, then it would seem that any inventor of a new and useful composition of matter may receive a patent for it and he may also, by filing separate applications, secure patents for every use of such composition that he may disclose. An inventor is not entitled to a patent unless his invention is new and useful. It would shock one's sense of justice if an inventor could receive a patent upon a composition of matter, setting out at length in the specification the useful purposes of such composition, manufacture and sell it to the public, and then prevent the public from making any beneficial use of such product by securing patents upon each of the uses to which it may be adapted.

In *In re Land,* 27 C. C. P. A. 863, 109 F. (2d) 246, 1940 C. D. 201, it appears that the applicant before the court had obtained a patent on a polarizing light screen, the patent disclosing the utility of the screen for automobile lighting systems, and the question was whether applicant could obtain a patent on an automobile headlight of which that screen formed a part. In its decision the Court said:

> The alleged invention which appellant seeks to cover by these claims is expressed in the form of combination claims which, obviously, are for old combinations. His allowed claims, which have now ripened into a patent, cover the polarizer *per se,* and we agree with the tribunals that it is not inventive to put appellant's polarizer to the new use stated or to use it as the claims require in an old assembly.

This last ruling is clearly applicable to the present case since, obviously, the spaced walls of a refrigerator and the insulating material between them form an old combination.

The attention of the Court is also called to the case of *Palmer Pneumatic Tire Co.* v. *Luzier* (C. C. A. 6) 90 F. R. 732. In this case the Court held a patent for a fabric, designed to be used in the manufacture of pneumatic tires, was invalid, in view of a prior patent granted to the same inventor on a copending application, disclosing and specifically claiming a tire made of such fabric.

CONCLUSION

It is submitted that, both on principal and on precedent, the holding of the Patent Office tribunals and the findings of the District Court were correct and that the judgment should be sustained.

Respectfully,

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R. F. WHITEHEAD,
Of Counsel.

SEPTEMBER 1943.

U. S. GOVERNMENT PRINTING OFFICE: 1943